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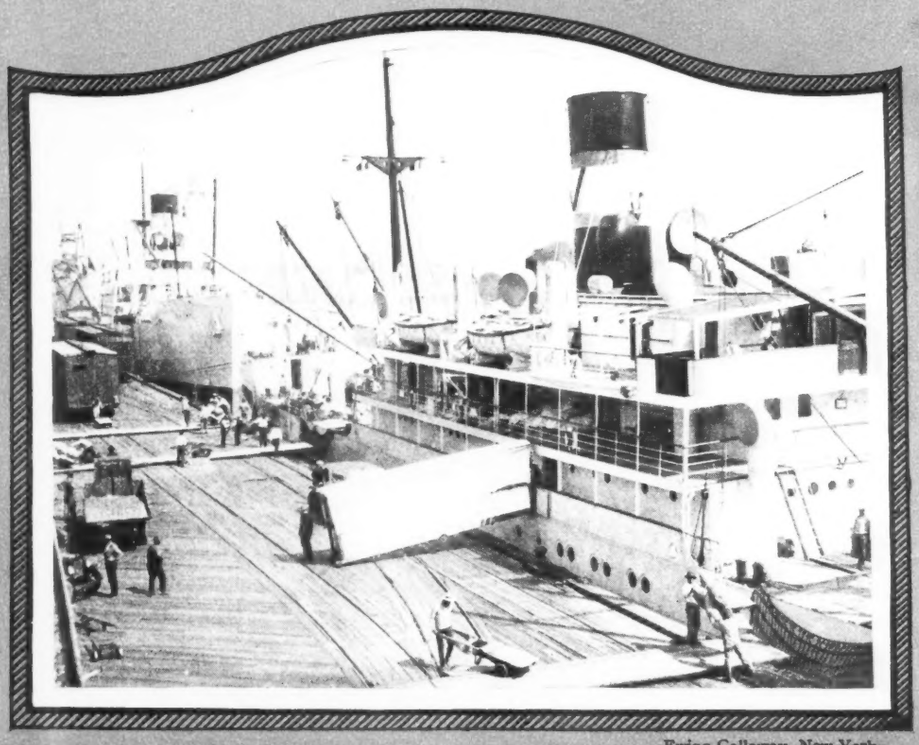

Ewing Galloway, New York

SOME SHIPS OF THE SO-CALLED BANANA FLEET LOADING AT NEW ORLEANS FOR THE RUN TO CENTRAL AMERICAN PORTS

New York Newspaper Building New Home
R. G. Skerrett

Buenos Aires Proud of Her New Subway
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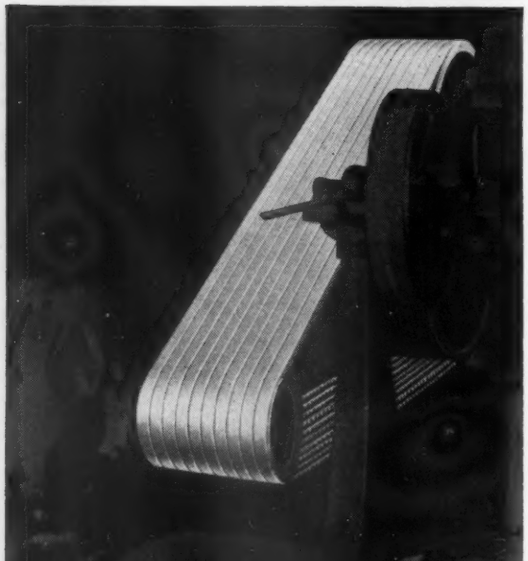

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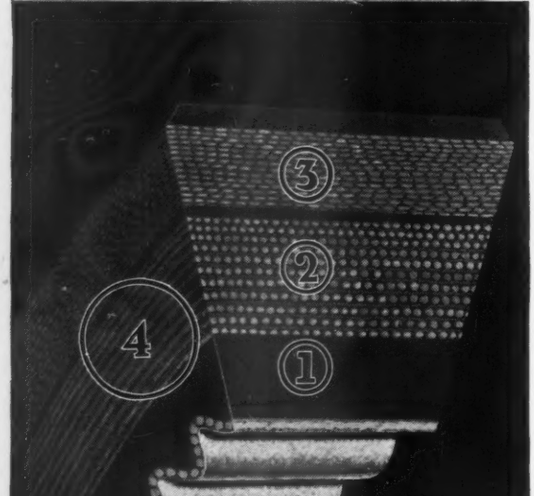

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As It Seems To Us

OUR THREE CENTURIES ON THE SEA

JUST three centuries ago, so we are reminded by *Dun's International Review*, the first commercial vessel built in America for transatlantic service was launched at Richmonds Island, Maine. In the course of the year 1631, that packet headed bravely eastward across the ocean and required, so it is said, approximately a month to complete her maiden voyage from her home port to England. That venture heartened others of our mariners of pioneer days; and, during the decades following, American built craft won their way to general recognition in transoceanic service under sail.

The first so-called steamship to cross the Atlantic was the *Savannah*, which did so in 1819. The *Savannah* had an overall length of 120 feet and a beam of 29 feet, and was rated a craft of 350 tons. The ship was constructed by the firm of Crocker & Fickett, of New York City, and her mainmast was set farther aft than first designed so that she could accommodate the steam power plant put in her. Her engine was turned out by STEPHEN VAIL in the Speedwell Iron Works, Morristown, N. J.; and her two boilers were built by DANIEL DOD, at Elizabeth, N. J. The purpose of the *Savannah* was to revolutionize transatlantic traffic; and her outfitting was considered as something of a venture. The ship had an engine rated at 90 hp., and this inclined, direct-acting low-pressure machine was counted upon to drive two collapsible paddle wheels which could be folded up like fans and hoisted in on to the main deck when the sea was too boisterous for their use. The *Savannah* used both coal and pitch pine for fuel.

On May 24, 1819, the *Savannah* put to sea under steam from Tybee, Ga., and, after a brief stop for fuel at Kinsale, Ireland, reached Liverpool in the evening of June 20. During the 27 days of that trip the craft was under steam for 80 hours, showing that her sails were her principal propulsive reliance. The *Savannah* spent some time in Europe, where she was generally admired before she made the return run to the United States. As a steamship, the *Savannah* could not be classed as an unqualified success, but she did serve to point out how steam might be utilized to advantage in transatlantic service, and to that extent she encouraged other shipowners and probably hastened the day of the ocean-going steam liner.

In the interval that has followed since the building of the *Savannah*, transatlantic steamers have developed mightily. Today there are liners of 57,000 tons and 130,000 hp. in this service capable of making nearly 30 knots an hour; and both the naval architect and the marine engineer are busy planning still larger and possibly faster craft. Surely the advance has been rapid and great since the *Clermont*, in 1807, marked the introduction of steam propulsion on the Hudson River.

EARTHQUAKES REVEAL NATURE OF EARTH'S INTERIOR

WHILE earthquakes do a deal of damage every now and then still they have served to reveal to the scientist much about the interior get-up of this terrestrial globe. Every earthquake sets up three distinct kinds of vibrations or waves. Two groups of these waves radiate into the interior of the earth while the third group travels through the surface crust. Each group of waves has its own speed of translation, and a seismograph will detect and record them, respectively. In this way, the expert can locate approximately the source or focus of a shock and determine the path taken by the resultant waves as they travel either through the earth or over its surface.

According to Mr. FRANK NEUMANN, of the United States Coast and Geodetic Survey, "Science has proved to its satisfaction that, while fluids and solids transmit certain kinds of waves, only a solid can transmit others. Evidence gathered from the direction and speed of earthquake waves indicates that the interior of the earth must be largely solid". In this way seismology has disclosed, so we are informed, that we are now living on a planet with a surface layer of solid rock ranging in depth from 25 to 40 miles. Below this comparatively thin skin there is a mantle of more elastic material that probably has a thickness of 720 miles. Then comes what is known as a transition layer nearly 1,050 miles in thickness; and beneath this layer there is a core, made up probably of such heavy metals as nickel and iron, which has a diameter of at least 4,300 miles. The density of this core is computed to be greater than that of steel.

It is the superficial layer of the earth's mass and a small contiguous zone just beneath it that constitute the unstable part of the earth, and it is within this region that all seismic activities are assumed to originate. Mr. NEUMANN tells us: "Scientists are working diligently to learn the precise nature and dimensions of the crust, because these must be known before the depth and the exact location of an earthquake focus can be determined". By thus studying earthquakes in their habitat, so to speak, seismologists hope some day to be able to anticipate these disturbances and so forecast their coming and warn dwellers in those regions where the reactions will be greatest.

INTEROCEAN CANAL PROBLEM NEARER SOLUTION

THAT the Panama Canal must be altered so as to handle expeditiously a larger volume of traffic or that another canal must be built in that general section of the Western Hemisphere has been apparent to students of the subject for some time. Accordingly, the Interoceanic Canal Board was called into being to study the situation and to make recommendations covering either the improvement of the Panama Canal or the digging of an independent canal through Nicaragua, as has been intermittently under consideration for years.

The Board has formulated four possible solutions of the problem. These are: A third set of locks for the existing Panama lock system; the cutting of a sea-level canal at Panama; the excavating of a sea-level canal in Nicaragua; or the employment of a lock-canal system over a suitable route within that country. So far so good, but the Interoceanic Canal Board has yet to express itself conclusively in favor of any one of the four projects.

The late Gen. EDGAR B. JADWIN—at the time of his recent death Chairman of the Board—is reported to have stated that a sea-level canal at Panama would be sufficient to handle interoceanic traffic for all time to come; and it was his belief that such a canal could be enlarged or deepened agreeably to traffic demands. While the Board has not yet estimated the cost of any of the projects considered, still it can be recalled that the cost of a Nicaraguan canal has been put at something more than $500,000,000, while the construction of an additional set of locks for the Panama Canal would entail an outlay of only $135,000,000.

It is reasonably fresh in the minds of a good many of us that there was much heated discussion before we started work on the Panama Canal concerning the relative merits or demerits of a sea-level route or of a waterway controlled by locks—such as now crosses the Isthmus.

Eminent engineers participated in the controversy that covered a considerable span; and the differences in opinion were in a large measure due to certain factors that were then somewhat undetermined in their values. Also there was wide variance of opinion about the ways Nature might react where the canal was subsequently dug through ground likely to readjust itself. Time has taught much in the interval.

It is earnestly to be hoped that the Interoceanic Canal Board will express itself definitely for one or the other type of canal and not leave this vital matter undecided. With the experience already gained in the case of the Panama Canal, surely a board of qualified experts should be able to give the nation something decisive.

Ewing Galloway

Hudson River with skyline of lower Manhattan in the distance.

Architectural sketch of the new home on West Street of the New York-World Telegram.

New York Newspaper Building New Home

This Metropolitan Daily Is Rearing a Ten-Story Structure on Ground Formed Where Once the Hudson River Flowed

By R. G. SKERRETT

HOW many of us realize that a goodly number of the skyscrapers that adorn lower Manhattan are actually standing on stilts that rest upon ledge rock far beneath them? It is this engineering expedient that has made them possible at a cost within reason; and yet this vitally important part of their structural get-up is effectually hidden from the eyes of those who are impressed with the way these buildings bulk above ground. The purpose of this article is to describe how the foundation has been made secure for a new newspaper plant now in the course of erection.

Increasing business and an incessant demand for more space have caused The New York Telegram to take in hand the financing of a large 10-story structure on West Street in the block flanked by Park Place on the north and by Barclay Street on the south. When completed and equipped, the undertaking will represent a total outlay of substantially $3,000,000. The building and the associate apparatus will be typically up to date and possess every feature today considered desirable in a publishing plant of this sort. The Telegram Building will add one more tall structure to the east side of West Street where, for many years, the buildings have for the most part been of few stories and rather unpretentious.

The modernizing of West Street has lagged conspicuously when compared with the upbuilding of neighboring sections of the downtown region of New York City. This state of affairs is attributable principally to the fact that most of the land contiguous to West Street is made ground and not, in itself, sufficiently stable to support towering and massive business structures. Furthermore, the ground-water level—affected by the state of the nearby Hudson River—lies normally only a few feet below the surface, and must be held at bay to prevent the flooding of the deep cellars ordinarily associated with present-day tall buildings.

The improvement of West Street architecturally remained well-nigh at a standstill until the art of foundation sinking with the aid of pneumatic caissons blazed the way to betterment. By recourse to pneumatic caissons it was possible to penetrate the water-bearing ground and to reach the rocky backbone of Manhattan so as to give a firm footing to the concrete columns that were to transmit the load of the superposed building to the underlying ledge 40, 50, or more feet below the ground level. By this method several towering and outstanding business structures were erected on West Street.

Successful as those undertakings have proved, still their foundation work entailed disproportionately heavy outlays and required much time. Indeed, the cost of foundation sinking checked the rapid development of West Street for business or industrial purposes, and this situation might have continued indefinitely had not the tubular-steel-pile method of foundation underpinning been devised. This method has been utilized successfully despite unsuspected difficulties in providing the bedrock support for the Telegram Building now going up. The structure will stand on 373 concrete-filled tubular piles driven through the ground to the underlying rock for distances ranging from 60 to 70 feet. These piles have been so arranged that they will bear the distributed load of the building. Before telling how this essential work has been done, it is pertinent that we touch upon the manner in which the original shore line of the southern end of Manhattan Island has been transformed in the course of the past century and a quarter.

According to the map reproduced with this article, the shore line of Manhattan has been altered since 1807 by the enveloping area that

Left—An air-operated hammer set on top of a tubular steel pile. Center—Pier 30 where twelve piles were driven before proper bearings were secured. The eight piles used to support a redesigned pier cap were cleared with a "Calyx" drill. Right—Blowing a pile preparatory to filling it with concrete.

is hatched to indicate the filling-in that has been done in the meantime. It will be noted that Greenwich Street in 1807, if it then existed below Vesey Street, must have been little better than a winding waterside road or path. Today, Greenwich Street below Vesey Street is three blocks in from the bulkhead line, and piers reach out into the river beyond that line. Successively, docks jutted out from Greenwich Street and Washington Street, and, later on, extended across what is now known as West Street; and step by step the old cribwork of the earlier docks was buried beneath made land, and buildings arose where once the river flowed unimpededly. The manner in which some of these changes occurred has been revealed in an interesting way during the excavating of the site for the Telegram Building. Some of the conditions thus exposed or encountered were unwelcome surprises to the contractor for the foundation.

The half block on which the Telegram Building is rising has an area of 24,500 square feet, and up to last August was occupied by a number of old buildings—among them being the North River Hotel, once a prosperous hostelry on the waterfront. Preliminary to planning the Telegram Building, test borings were made. Most of these were sunk around the outside of the structures then standing, and only a very few borings were made inside of any of the buildings. None of the borings disclosed any underground obstructions between the surface level and the ledge rock. In short, conditions seemed to be altogether favorable to the rapid and unhampered driving of the tubular steel piles; and the number and the disposition of these piles were decided upon accordingly.

Without going into details, the plans called for the symmetrical arrangement of six piles for the average pier cap composed of a large reinforced concrete block. So that each pier cap should be able to carry properly its designed load it was essential that the supporting piles give an evenly distributed support to all parts of the cap—hence the symmetrical arrangement of the piles. This point must be kept in mind in order to appreciate the problem confronting the contractor when unexpected obstructions interfered with driving the piles downward to bedrock. This important work was done by the George J. Atwell Company, subcontractor for the Adelson Construction & Engineering Corporation, general contractors for the erection of the Telegram Building.

To make it possible to excavate the site, the George J. Atwell Company was obliged to surround the area on the three exposed sides with a wall of steel sheet piling driven to a suitable depth to steady the ground and to check the inflow of ground water which at mean high tide, is only 5 feet below the street level. With this done and the area cleared of the last of the old buildings, the work of driving the tubular piles began. Operations proceeded with little difficulty within the area of what might be described as the western half of the site. The ground there consisted of fill beneath which lay successively, strata of river mud, sand, sand and gravel, clay, and much very fine sand. The fill was found to contain boulders of various sizes; but as a general thing none of these was big enough to seriously obstruct the driving of the piles.

Underground conditions within the remaining half of the site were much less favorable at a number of points where piles had to be driven. The air-operated hammers employed for this purpose weighed, respectively, 6,760 pounds and 10,000 pounds. The lighter of these hammers struck a blow of 8,200 foot-pounds, while the heavier one struck a blow of 15,000 foot-pounds. Neither sufficed to drive the piles through the heavy timbers of an old pier or through a large boulder 2 feet thick, that were met by certain of the piles. In fact, in a number of instances the piles were so damaged by the hammer blows that they had to be withdrawn. The piles used were 18 inches in diameter, with walls ½ inch thick, and were made up in two sections held together by an interior sleeve, 1 inch thick, that had an inside diameter of 16 inches.

The seriousness of the situation was emphasized by the fact that the obstructed piles, to serve their purpose, had

Some rock cores removed with "Calyx" drills in clearing the way so that piles could be driven.

1—This 500-cubic-foot XL portable compressor furnished some of the air required for the foundation work. 2—An XRB compressor that supplied air to operate hammers and to blow tubular steel piles before filling them with concrete. 3—One of the two "Calyx" drills set up at the east building line and used on Pier 18 to clear five blocked piles. 4—The blowing-air receivers with attendant holding lever of quick-opening valve. 5—Pier 12 where a "Calyx" drill made three 20-inch holes through an obstructing boulder so piles could be driven.

Looking southward across site of Telegram Building. Cribwork of old dock underlies left-hand half of the plot.

to be driven down to bedrock. Failing in this, other piles had to be substituted and so arranged that all those successfully driven should furnish the necessary symmetrical support for the surmounting pier cap. In the case of one pier, the obstructions were such that twelve piles instead of six had to be driven before proper bearings were secured! In this critical stage of operations, the George J. Atwell Company did something novel—the company had recourse to two WS "Calyx" drills, which were used to clear the way for the effective driving of the tubular piles.

"Calyx" drills have been employed for many purposes in cutting cores ranging in diameter from 1½ inches to 3 feet, and were, therefore, amply able to cut holes of 15 and 20 inches in diameter, such as were required in meeting the situation presented in the foundation work for the Telegram Building. The bits used had a uniform length of 10 feet; and the bit of each drill was directly driven by a 3-inch seamless-steel drill pipe—the connection between the core barrel or bit and the driving pipe being a quick-breaking tool joint. The prime mover of each drill was a 15-hp. direct-current motor. This type of motor was required in order to utilize the current available.

Where the obstruction consisted of buried cribbing made up of heavy timber, a way was cleared through the interfering woodwork by equipping the "Calyx" drill with a 15-inch bit and operating downward through the tubular pile as a guide. After the bit had thus perforated the cribbing it was easy enough to hammer the pile through what remained of the timber. Again, the same size tool was used to clear a pile packed so tight with boulders and earth that the blowpipe could not be inserted in the tube to make the pile ready for filling with concrete. In the case of Pier 30, where twelve piles had to be driven, eight of them were cleared with the aid of the "Calyx" drill.

Perhaps the most interesting applications of the "Calyx" drills were those in which boulders lay athwart the descending path of three of the piles for Pier 11 and one of the piles for Pier 3. Finding it impossible to hammer the piles through the obstacles, the superintendent, Mr. G. S. Kelley, decided to try those drills on what was undoubtedly rock. For this work a 20-inch core barrel was provided. The procedure was as follows: A 22-inch steel shell was driven into the ground to a depth of 15 feet and blown—the shell serving as a guide or sleeve for the bit during the early stage of its penetration. In this way, three holes were successively drilled through a boulder, 2 feet thick, that underlies Pier 11 at a depth of 20 feet. It was a relatively easy matter after the withdrawal of the bit to drive the 18-inch piles through the holes thus made for them. The same course was followed in dealing with a boulder in the path of one of the piles of Pier 3.

All told, the "Calyx" drills were used either to clear the way for or to clear out a matter of twenty piles. By so doing this work, it was possible for the contractor to place the piles in the positions originally planned for them, thereby obviating the redesigning of the pier caps in order to insure a satisfactory distribution of the loads eventually to be borne by them. Furthermore, the employment of the "Calyx" drills saved much time and considerable money. In this connection Mr. William Ginsberg, chief engineer for the Adelson Construction & Engineering Company, has said: "I consider the 'Calyx' drill a definite and desirable piece of construction equipment when called upon to drive piles in obstructed ground".

To those unfamiliar with this method of driving piles to bedrock or to resistance in forming groups of them to serve as piers for heavy or towering buildings, let it be said that the tubes are blown free of mud, stones, etc., with compressed air released suddenly from the bottom end of an inserted pipe of sizable diameter—say, 3 inches. This method of cleaning in advance of filling with concrete can be employed with comparative ease when a pile penetrates hardpan or when the underlying rock is soft enough for a pile to be driven into it about an inch so as to seal its lower end and prevent the influx of the outlying mud or sand. At the site of the Telegram Building, the contractor had to contend with ground water and much quicksand; and his problem was to keep the sand out of a pile until he could fill the bottom section with concrete.

The bedrock at that part of Manhattan is too hard for a pile to be driven into it, and continued hammering would only damage the pile. Therefore some other way had to be found that would serve to keep quicksand from forcing its way into a pile immediately after it was blown. By juggling the compressed air so as to exert a back pressure at the bot-

Site of the New York Telegram Building with West Street lying on farther side.

tom of a pile directly after final blowing, and by using a quick-dumping arrangement for chuting concrete into the pile at the right moment, the difficulty was overcome. To be explicit, sufficient compressed air was discharged from the bottom of the blowpipe after the cleansing blast to hold the quicksand at bay for a while, and the weight of the descending mass of concrete increased the effectiveness of that "plug" of compressed air. The arrangement was so effective that 1½ cubic yards of concrete could be dumped in a pile—depending upon conditions—in from 15 to 21 seconds.

In blowing a pile that has been driven to resistance, the practice is to work the blowpipe down several feet into the compacted material confined within the pile. Then air is discharged suddenly from the lower end of the pipe and ample pressure built up beneath the mass to expel it with considerable velocity. At the same time, this rapid movement creates a suction below the air discharge and tends to loosen and to start an upward movement of the earth, rocks, etc., lying below the pipe. In this way the previously compacted mass is made easier for the pipe to penetrate in readiness for the next lift or blow. This procedure goes on step by step until the pile is blown clean and is put in a condition to receive its filling of concrete.

At times during pile driving the tubes were hammered downward through a formation composed largely of small boulders and sand. In such instances, if the boulders still remained after much of the sand had been dislodged by blasts of compressed air released from the blowpipe, then a "Calyx" drill with a 15-inch core barrel was brought into play. Before the bit was inserted in the pile sufficient concrete was dropped in the tube to make a seat for the core barrel and for the cutting shot or "Calyxite". This procedure proved satisfactory in quickly cutting through obstructing boulders so that the pile could be blown.

Several of our illustrations show the 3-inch blowpipe, the associate gooseneck at the upper end of that pipe, as well as the connecting flexible line leading to two interconnected air receivers. At one of the receivers the air line was hooked up to a quick-opening air valve, operated by a lever, so that a sudden and large shot of air could be put through the line to act explosively in lifting and expelling mud, sand, and small rocks. The force of the resulting discharge is graphically illustrated by one of the accompanying pictures. The blowing receivers carried air at a pressure of 110 pounds. The air was supplied by an XRB 15&9¼x10-inch Ingersoll-Rand compressor and an XL 500-cubic-foot Ingersoll-Rand portable compressor.

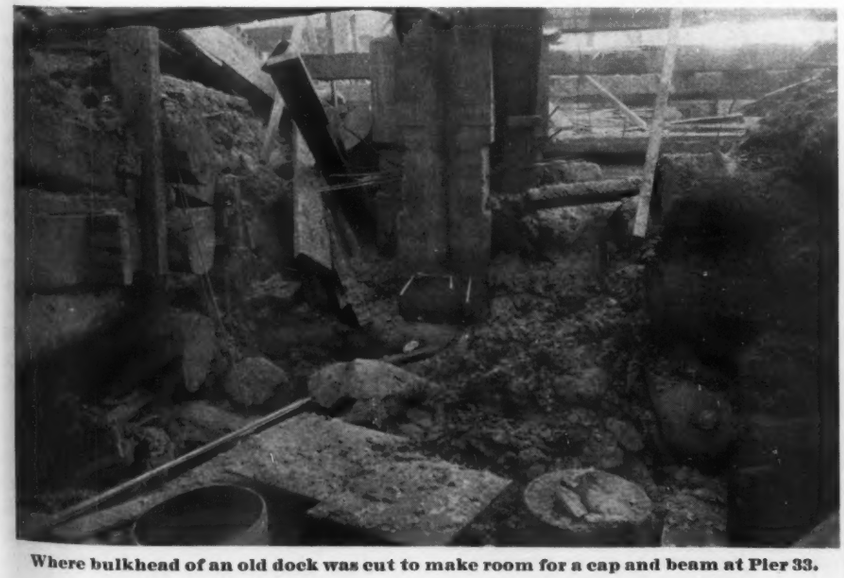
Some of the timbers of a buried dock that were removed in clearing the site. Note short section of old wooden water pipe uncovered during operations.

One naturally wonders what could have been the conditions along that section of the waterfront of New York City when the old cribbing that was uncovered served as part of a busy dock. In clearing away some of the timbers in excavating for the basement of the Telegram Building a section of a wooden water pipe was dislodged—the type of main used in distributing water when the Manhattan Company was first organized in 1799 to provide water to the people then dwelling in lower Manhattan.

That bit of old water pipe is a reminder that politics at the close of the eighteenth century did not differ much from now in its effect upon public affairs: things were done at Albany even then that were not evident on the face of legislation. For instance, Aaron Burr obtained from the State Legislature the charter for the Manhattan Company. His political enemies would have fought that franchise had they known that the charter was primarily to permit the company to do a banking business and only incidentally to furnish water to the citizens of New York City. History has a way of repeating itself.

In a sketch of the evolution of the Manhattan Company and its development into the Bank of the Manhattan Company is the following informative paragraph: "For many years (the Manhattan Company) furnished the city's chief water supply, pumping its water from the Collect, or from its wells at Cross and Duane streets, into hollow log pipes distributed underground through the lower portions of the town". That virtual monopoly was not seriously disputed until after the War of 1812. Therefore, the piece of wooden water main recently excavated at the site of the Telegram Building gives us some hint of the time when that pipe served its purpose at that point.

More evidence of the period when the old dock was in use was uncovered in blowing one of the steel piles driven at the southeastern corner of the plot. That blast brought up from underground a number of coins—all but three of them dropping back into the



Where bulkhead of an old dock was cut to make room for a cap and beam at Pier 33.

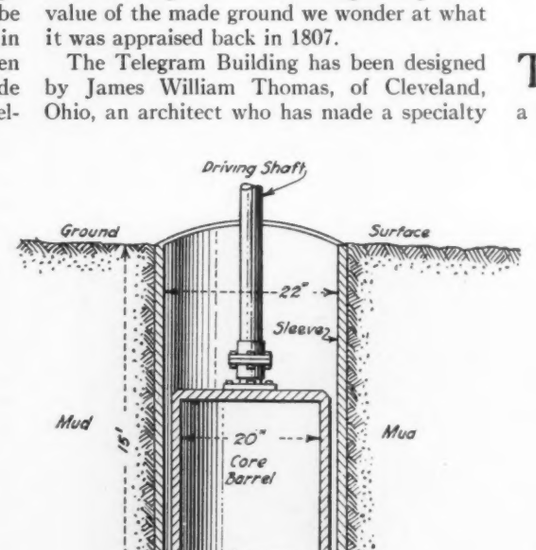
© Townsend MacCoun

Map of lower part of New York City showing original contour of Manhattan Island. Shaded area indicates made ground, and small circle at left marks site of the Telegram Building.

surrounding mud. Of those recovered two were big Liberty pennies, dated 1801, and the other a Spanish silver piece, dated 1782. These mute witnesses of the past appeal to the imagination and cause one to wonder just what were the waterfront activities in the days when those coins may have been dropped overboard or may have fallen through an opening in the wharf floor. One can be reasonably certain that the loss occurred in those years following the Revolution when New York City was striving for world trade and was bent upon outstripping Philadelphia, which was then of foremost importance commercially. With the removal of the restrictions previously imposed by Great Britain, New York advanced by leaps and bounds in maritime business. The people had learned much by the education of war, and when peace came they were intent upon making the most of the port's natural advantages. Their aim was to utilize New York's strategic position as an outlet for the products of the country's soil as well as a gathering place for merchant fleets engaged in moving our agricultural plenty overseas or employed in distributing it hither and thither along our extended seaboard. It was as the immediate or the later expression of this maritime urge that the old dock underlying the site of the Telegram Building came into being. Apart from bringing back vividly days now long gone, the section of water pipe and the old dock timbers remind us how much lower Manhattan's waterfront has changed in the meanwhile. The transformation is an astonishing one, and the newspaper plant now under construction will add emphasis to it.

There are maps extant of Manhattan Island that show that the site of the Telegram Building was once owned by Columbia University; and when that grant was made by far the larger part of the property lay under water at high tide. Knowing the present value of the made ground we wonder at what it was appraised back in 1807.

The Telegram Building has been designed by James William Thomas, of Cleveland, Ohio, an architect who has made a specialty of planning and constructing newspaper plants. Messrs. Shank & Fisher, also of Cleveland, are serving as consulting engineers.



Sketch of way in which the 20-inch core barrel, with a 22-inch sleeve, was used when drilling holes through a boulder having a vertical thickness of 2 feet.

AIRPLANE TUBING OILED INSIDE BY PNEUMATIC PRESSURE

CONSIDERABLE tubular steel is used in the construction of airplanes to assure essential lightness. These members, being hollow, are exposed to corrosive attack both inside and outside and must, therefore, be made rustproof to prevent weakening and, possibly, disaster.

In the case of the inner surfaces, this is done after the welding operations are completed and by the application of one or the other of a number of suitable products such as linseed oil, which is extensively employed for the purpose. To facilitate this operation, small holes, approximately 1/16 inch in diameter, are drilled through the longerons at points where they join the shorter tubing—thus interconnecting all the members of a fuselage or landing gear.

In order to obtain best results, says C. E. Kirkbride, project engineer at the Naval Aircraft Factory, Philadelphia, Pa., hot linseed oil should be forced through the tubing from the bottom upward with compressed air and allowed to drain off, after which all openings should be sealed, made air- and watertight, by means of drive screws. This method of protecting the inner surfaces of steel tubing is recommended to promote safety. Corrosion on the outside can easily be detected and stopped; but more than ordinary precautions are necessary to keep the inner surfaces, which cannot be seen, free of harmful rust.

CONVERTIBLE MOTOR VEHICLE

THE London, Midland & Scottish Railway has been conducting extensive tests with a new vehicle that is designed to run with equal facility on either rails or roads. The "Ro-Railer", as the motor-driven truck or bus is called, is equipped with two sets of wheels: one set of flanged wheels for use on rails and another set with pneumatic tires for road work. The change-over is effected by raising or by lowering the pneumatic wheels.

With this exception, the "Ro-Railer" differs little in appearance from the ordinary truck or bus. The primary purpose was to provide a vehicle that would make it possible to transport products from farms and from factories to their destinations without the need of transferring or rehandling them. The truck has a carrying capacity of 3 tons, while the bus type seats 26 persons. The engine develops a maximum of 120 hp. and is fitted with a supplementary gear box that gives increased speed on long rail runs with lower engine speed. This arrangement of double wheels, if practicable, would add considerably to the radius of action of such common carriers.

Two black bears stage a friendly scrap in the front yard of their new home.

Happy Homes for Bears and Monkeys

Concrete Was Made to Simulate Rock in Providing Natural-Looking Habitats for These Animals in Brackenridge Park, San Antonio, Texas.

By C. H. VIVIAN

THE bears and monkeys in Brackenridge Park at San Antonio, Tex., have new homes. As an item of news this is hardly a sensational announcement. But there are some interesting facts in connection with these abodes. They are not ordinary animal enclosures. They represent an expenditure of more than $100,000. It is well that the tenants do not have to pay rent, for it is difficult to conceive how they would be able to satisfy the landlord on the first of each month.

These animal residences, which have been provided by the city, contain such modern conveniences and luxuries as electric lights and swimming pools. The monkeys have steam heat in their apartments, and the bears have a ventilating system to cool things off in the summertime. The houses were laid out by architects with the same painstaking care that would be exercised in preparing plans for a millionaire's villa. They were built of concrete, reinforced for strength, and finished with pleasing exterior effects. The premises were then landscaped and beautified with trees, shrubs, and grass.

The purpose of the enclosures is twofold: first, to provide comfortable quarters for the animals that have some semblance of their native habitats; second, to more effectively display the animals to visitors. The enclosures are of the barless type of construction that has been used before at Denver, St. Louis, and other points; but the San Antonio structures possess certain distinctive features.

Three terraces for bears were built on the floor of an abandoned quarry which at one time produced materials for cement-making. The existing rock face was utilized as a back wall for the enclosures. The work included the excavating and the lining with concrete of a moat, along the front, 13 feet wide, 12½ feet deep, and approximately 300 feet long; the erection of two reinforced-concrete houses and of two stone division walls; the digging and the lining with concrete of a swimming pool in each unit; the construction of artificial-rock exteriors to conceal the houses and the division walls; the treating of the floors of the terraces to resemble natural rock; and the building up of the natural back walls with artificial stone to render them unscalable by the bears.

The monkey enclosure, known formally as "Primate Paradise" but more generally called "Monkey Island", is at one end of a natural ridge or hogback. The completed structure takes the form of an island, 75x160 feet, surrounded by a moat, and the whole is enclosed by a wire fence. The moat is 15 feet wide at the top and 15 feet deep. It was excavated in rock, and the outer side reinforced by a concrete retaining wall at the top. Upon the island is a reinforced-concrete monkey house, concealed within a cave. The superstructures of the cave, retaining terraces, a longitudinal ridge down the center of the island, and two swimming pools were all cast in concrete and shaped and colored so as to simulate natural rock.

Extensive plumbing facilities were provided in the enclosures to supply water for the moats, swimming pools, and hose connections, as well as to drain the moats, swimming pools, animal houses, and adjoining display spaces. Electric lights were put in all animal quarters, and a thermostatically controlled electric heating system was installed in the monkey houses.

Compressed air was used in several ways to further the construction. All the excavating was done with the aid of rock drills. The general contractor, W. C. Thrailkill, of San Antonio, had three Ingersoll-Rand Type 20 portable compressors and a number of "Jackhamers" and paving breakers on this work. Compressed air was also employed in guniting and in building up the artificial-rock surfaces required in connection with the bear terraces. It is this last-named part of the undertaking that holds particular interest, and which will be described here. Because of the unusual nature of the work, it was awarded to Mr. Thrailkill on a cost-plus basis after the preliminary construction had been completed.

The greatest difficulty encountered in making and erecting this artificial stone was to produce a realistic imitation of the natural rock adjoining it. Both in color and texture

it had to approximate closely the stone left in place at the back wall. This matching was made particularly hard because the two varieties had to meet at certain points and even overlap where the natural rock walls were to be extended or overhung with artificial stone to make them unscalable by the bears. The matter of matching the color was further complicated by the fact that the original walls, comprising the face of the old quarry, had been weathered and eroded until the color varied from a light cream to a black.

As an initial experiment, a wall was built by laying large stones excavated from the moat in mortar to match and by finishing the joints flush. This plan was found unsatisfactory because the completed wall had an artificial appearance and also because of the shortage of large, sound pieces of rock. It was then decided to make up the rock synthetically by a process that will be described.

First of all, reinforced plaster casts, 3x5 feet in size, were taken from various typical rock surfaces throughout the park. In addition, in order to duplicate a rock formation intact, a cast was made of the entire section and then cut into pieces to facilitate handling. To make it easier to remove the casts, the rock was cleaned with a wire brush, all deep holes or undercut places partly filled with soft clay, and the surfaces then given a coat of soap solution.

The casts were taken to a central casting yard, where the edges were trimmed and any defective spots were carefully patched. Then a heavy reverse cast was made of each. These served as master casts, and from each of them was fashioned a lighter cast to act as a mold or form for the respective artificial-rock construction. Each cast was reinforced with fiber and 2x2-inch brace strips of wood.

While the casts were being made, the two core walls dividing the site were constructed. They were built of rubble stone, and formed a rough "V" pointing away from the rock cliff at the back. The walls were for the purpose of retaining earth fill so as to permit planting on top of the divisions, and also to form a rigid support for the bracing of the artificial-rock construction.

Care and ingenuity were required in the erection of the plaster casts, since it was necessary that all finished walls be unscalable by the bears and also that they present the appearance of a continuous surface rather than of a number of assembled units joined together. The various areas making up each surface had to be different in conformation so as to prevent it from looking mechanical. The workmen caught the spirit of the task, and quite a rivalry sprang up among them to see who could get the most natural effect. As a result of their care, comparatively few corrections had to be made.

In assembling the casts, a row of them was first set up about 2 feet away from the house or rubble stone wall. A concrete foundation slab was then poured between the casts and the wall with its surface sloped to low points for drainage. Steel dowels were inserted in the slab, 2 inches back from the face of the plaster forms, for the securing of reinforcement for the rock construction. Additional plaster casts were then set on top of the first row. They were braced to wood scaffolding. The surface they formed was checked from the inside, necessary corrections were made, and all joints carefully pointed and textured.

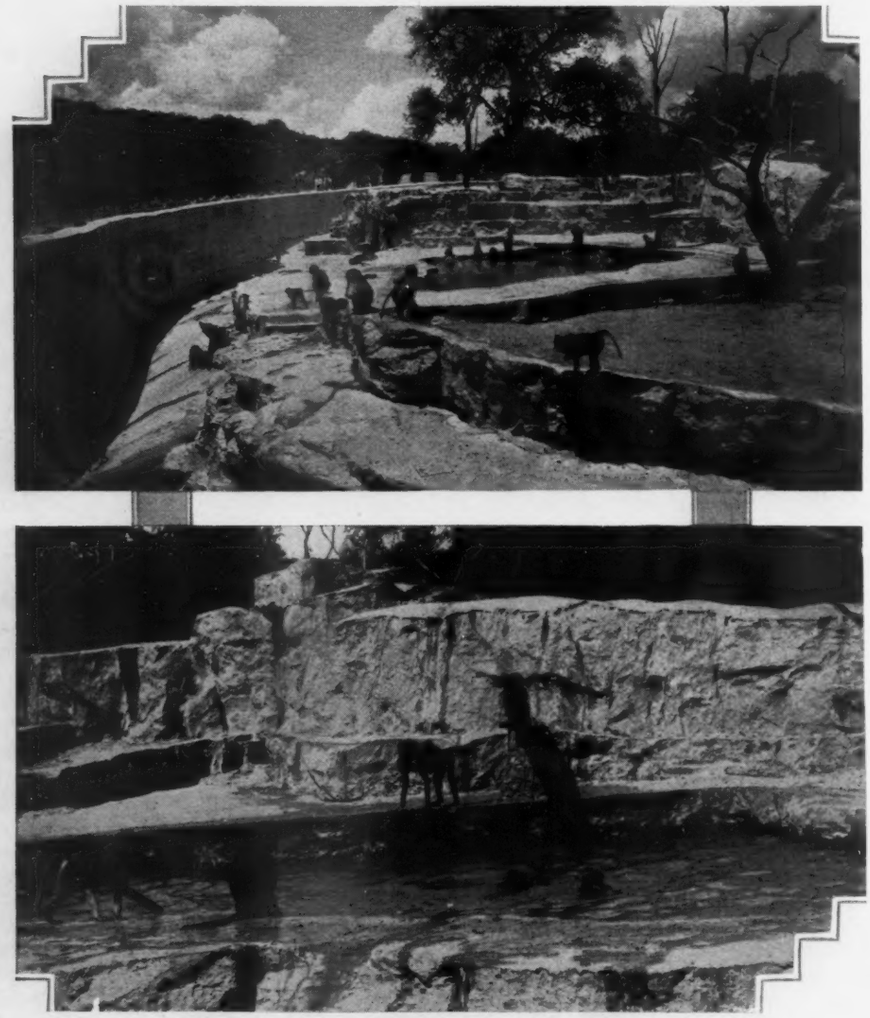
Quarter-inch round bars of steel, spaced 12 inches apart in both directions, were applied to the inner surface of the casts for reinforcement. The bars were bent with small hickeys so that they accurately conformed to the inner surface of the forms. These bars were held in position by copper wires passing through the forms and were kept ½ inch away from the casts by means of galvanized wire chairs or small pieces of cement mortar. Hooks for the fastening of braces, and dowel bars to receive the roof construction were wired to the main reinforcing.

To reduce the adhesion of the casts to the stone and to make their removal easier, they were given a coat of lubricating material immediately before the placing of the artificial stone. Various materials and mixtures designed for this purpose were tried, and it was found that the most satisfactory results were obtained with a compound of stearine, cup grease, kerosene, and French talc. Although the reinforcing bars were also coated by this method, it was found by actual test that the material was entirely removed from them during the deposition of the stone mixture.

All artificial-rock construction of any height was of gunite made up of a mixture of one part standard gray Portland cement and of three parts coarse, washed red sand. These materials were adopted after much experimentation. Yellow ocher was found to be the best and the most economical coloring agent. To give the artificial rock the strong yellow and dark gray areas of the natural stone, additional amounts of yellow ocher or of black mineral color were occasionally introduced into the charging hopper.

At the outset one guniting machine was employed with a crew consisting of an operator, a nozzleman, a laborer to assist in moving hoses, and two laborers to screen sand, mix materials, and charge the hopper. As the work progressed, a second and larger machine was added. This served to apply the second or backing-up coat and to build up structural members and roof slabs. The same portable compressors that had been used on the rock-excavation work supplied air for the guniting.

The first or color coat was approximately



Down by the old swimming hole on Monkey Island.

A group of views of the bear terraces, showing how skillfully the artificial and the natural stones have been blended.

Left—A part of one of the completed terraces. Right—The moat and one of the reinforced-concrete bear houses during construction.

1 inch thick to embed the reinforcing. After this had partially set, it was sprayed with water and the backing-up coat applied to increase the total thickness to from 2½ to 3 inches. Anchor rods and also beam and column reinforcing, necessary to brace and to support overhanging and offset portions, were then put in position and the ends gunited to bond them into the construction. Trough-shaped wood forms were then placed around the steelwork and the brace members built up with gunite deposited against the forms.

During the application of the gunite, the nozzleman worked in cramped quarters between the forms and the concrete or masonry walls. The clearance was as little as 18 inches at some points, but averaged about 30 to 36 inches. Because the nozzleman and the machine operator could not see each other, they arranged a set of signals with the aid of electric bells and push buttons.

In spite of the treatment of the mold surfaces with lubricant, considerable difficulty was met in removing the forms after the gunited material had set. As the workmen became more practiced, however, a greater proportion of the casts was removed intact. They were then trimmed and rebraced where necessary and used in other locations. Many of them were set up four times.

Spaces between the artificial walls and the concrete houses or masonry retaining walls were roofed over with gunite slabs which were depressed at the center to receive earth fill for planting. This gunite was applied from above against metal-lath forms backed up by building paper and supported by reinforcing steel.

After the plaster casts had been removed, the completed surfaces were examined and any defective spots or sand pockets were pointed with colored mortar. All exposed surfaces were sand blasted to get rid of grease and dust. A reddish sand, containing some silt, was used to give the artificial stone a color tone that blended well with the natural rock. The success of the efforts to reproduce natural stone may be judged by the fact that visitors are frequently heard to comment upon the amount of work that must have been involved in cutting the terraces out of solid rock and leaving the divisions between them untouched.

A gunite wainscot, about 8 feet high, was applied at the base of the quarry face forming the rear wall of the terraces to prevent the bears from digging into the natural rock. All cracks and clay pockets were dug out and shot full of gunite. At the rear of the terrace which was to be occupied by the polar bears, the natural rock sloped upward so gradually that the bears could escape. To correct this, plaster casts were erected to simulate a large cave, and gunite was placed in the usual manner. This artificial structure was then reinforced with concrete.

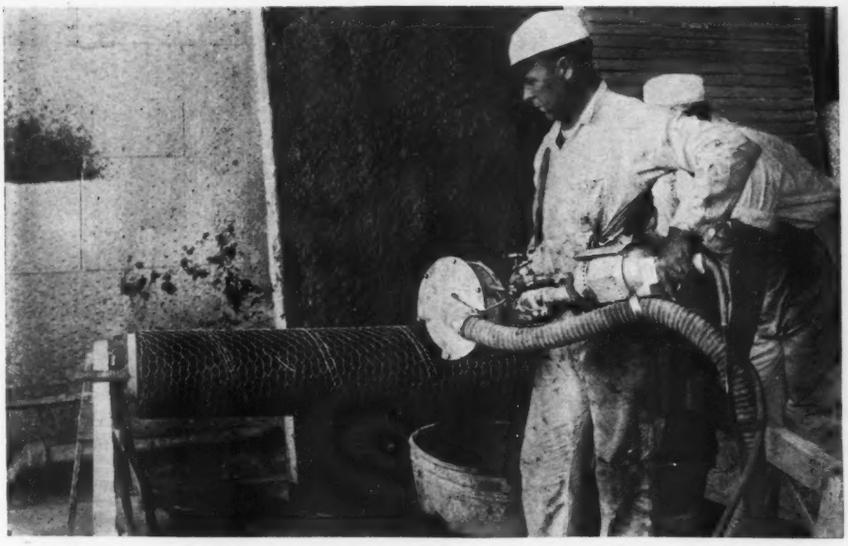
Monkey Island as seen from a neighboring hill.

The floors of the terraces were constructed by pouring slabs of concrete in irregular strips, with each succeeding strip overlapping the preceding one so as to produce a series of setbacks or steps from the front. Narrow sections of plaster casts were used as forms for the exposed risers, and the surface of the slabs was colored and textured to resemble rock. The whole was sloped toward the moat to provide drainage. Just back of the moat a depressed shelf was built with its surface sloped to drains. This prevents drainage from the terraces and houses from running into and contaminating the moat.

The bear enclosures, which are concealed by the artificial-rock walls, contain central service passageways with dens on either side. Lifting doors to permit the bears to pass in and out of the houses and from one den to another are controlled from the passageways. Above the dens and passageways in each house is an air space connected with monitors on the roof. This ventilating system keeps the temperature comfortable even on the hottest days of summer. The floors of the animal quarters are of concrete and are sloped to drainage gutters on either side of the central passageways to permit flushing with a hose with a minimum of labor. Each of the two bear houses has two hospital dens.

On Monkey Island, some of the natural rock was hard enough to leave exposed. All soft or badly fractured rock was covered with artificial rock made by pouring concrete against plaster forms to create irregular steps. The monkey house and the ridge down the center of the island were also masked with artificial rock, and an artificial-stone platform for feeding purposes was built in front of the house. The remainder of the island was covered with sand or earth, and with artificial rock risers. All made-up rock was sand blasted upon completion to give it an even color.

Eight months were required to complete both enclosures. The work was designed and supervised by the architectural firm of Adams & Adams, of San Antonio, with G. M. Baker in direct charge. Mathews & Kenan of San Antonio prepared the structural design for the moats and animal houses.



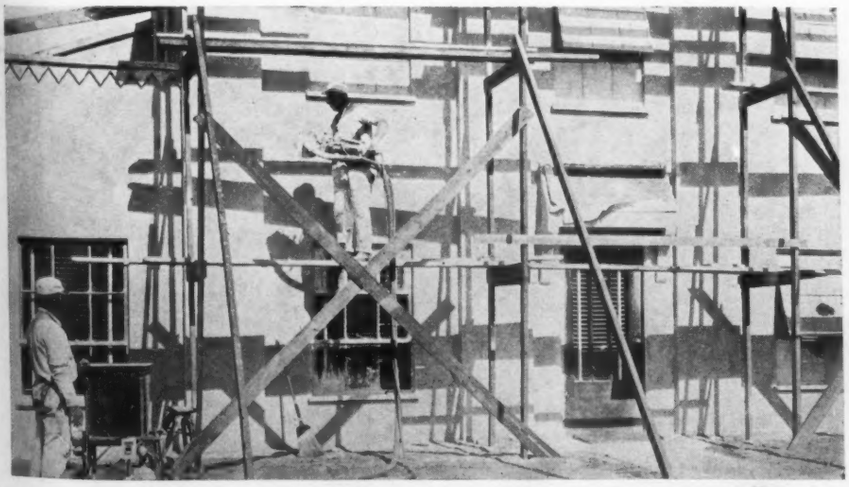
The working end of the plastering machine. Compressed air is used to feed the dry ingredients to the mixer.

PLASTERING BY MACHINE

PLASTER can now be applied by machine to concrete, brick, wood and metal lath, wire, in fact to any surface upon which a coating of this sort has heretofore been laid by hand. The equipment capable of doing this work has been developed by a California plasterer, who recognized that approximately 80 per cent of the time consumed on a given job done by hand labor is wasted in carrying the heavy mortar from the board to the wall and in other unproductive ways. The Conley plasterer has cut out this lost motion, as it handles the dry ingredients and applies the mortar, respectively, by air pressure and by centrifugal force.

Compressed air is used to deliver the dry materials through 25 feet of hose to the machine, where revolving blades thoroughly mix them. Water is added last so as to prevent any setting of the plaster until after its application—the plastic mass, as soon as it is formed, being thrown against the wall surface by the centrifugal action set up by the mixing blades and by the rotating brushes with which the apparatus is equipped. Trowels are required only to spread the mortar after it is in place. By means of dual controls the operator can start the air supply and set the mixer in motion; and he also regulates the flow of water to the nozzle.

Colored stucco, acoustic plaster, white coating, and sand finish can all be handled by the machine, which has a maximum capacity of 60 pounds of dry ingredients per minute or about 10 tons in an hour. This means that one man and an assistant can apply from fourteen to fifteen tons of mortar during a working day. According to the manufacturer, this is from six to ten times faster than plastering can be done by hand, the rate of speed depending, of course, upon the mix and upon the kind of work being done.

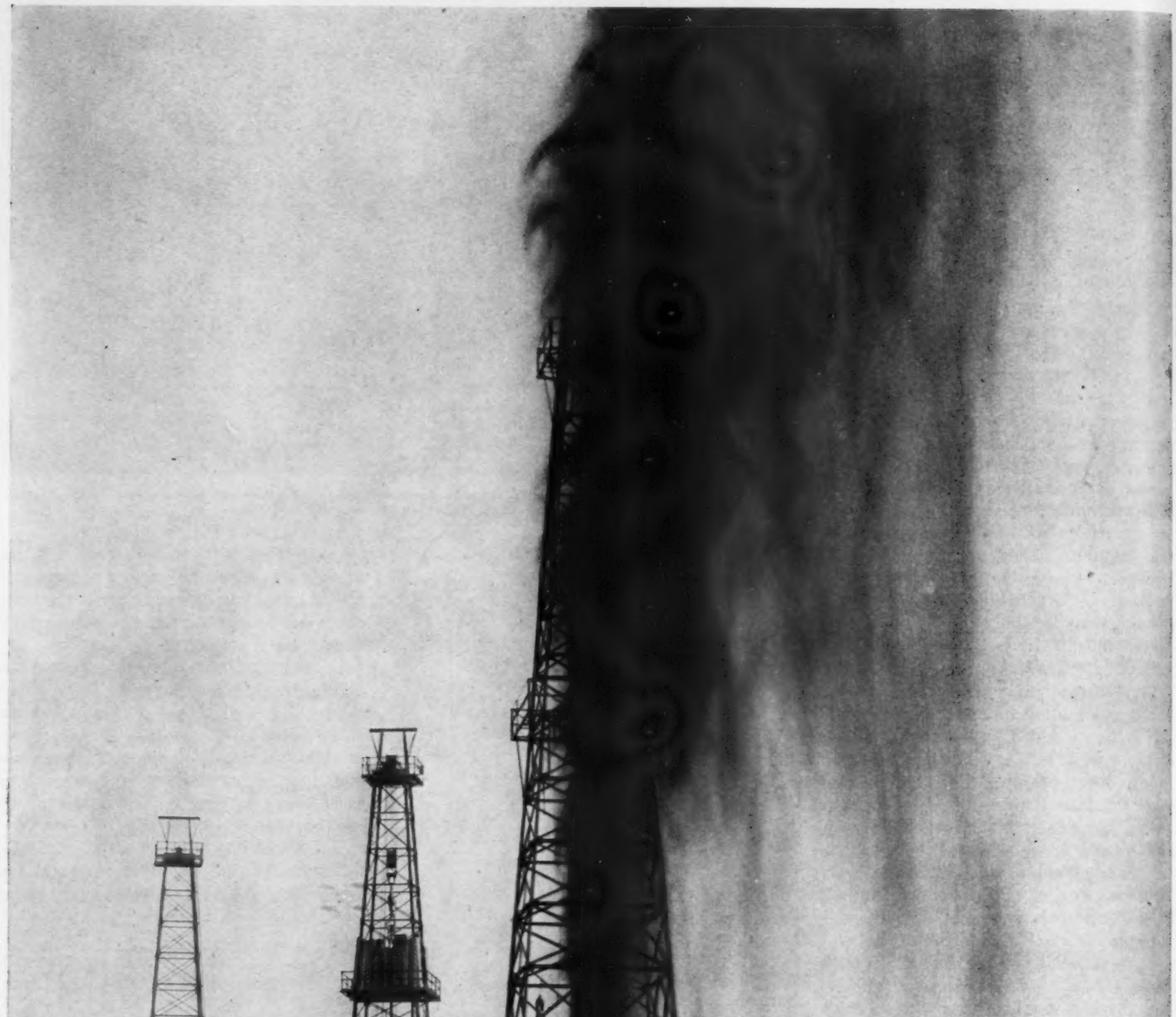


Stuccoing a house in California by means of the mechanical plasterer.

STEEL DIRECT FROM IRON ORE

IN these pages reference has previously been made to the Flodin furnace for the making of steel direct from iron ore. Reporting on the process, the chief engineer of the Fagersta Works, in Sweden, where it has been in use since 1928, said: "The large-scale experiment has turned out well. The plant functions without any trouble; and the process has proved serviceable in actual working. The quality of the steel obtained is also good. Twenty men are now employed on this furnace; but with large units and more suitable arrangements the output can be increased without increasing the number of attendants —making the labor cost no higher than in the case of Bessemer and open-hearth steel furnaces. The amount of charcoal burned is about half that required by the blast furnace, and the consumption of electric current is no higher than in the manufacture of electric pig iron.

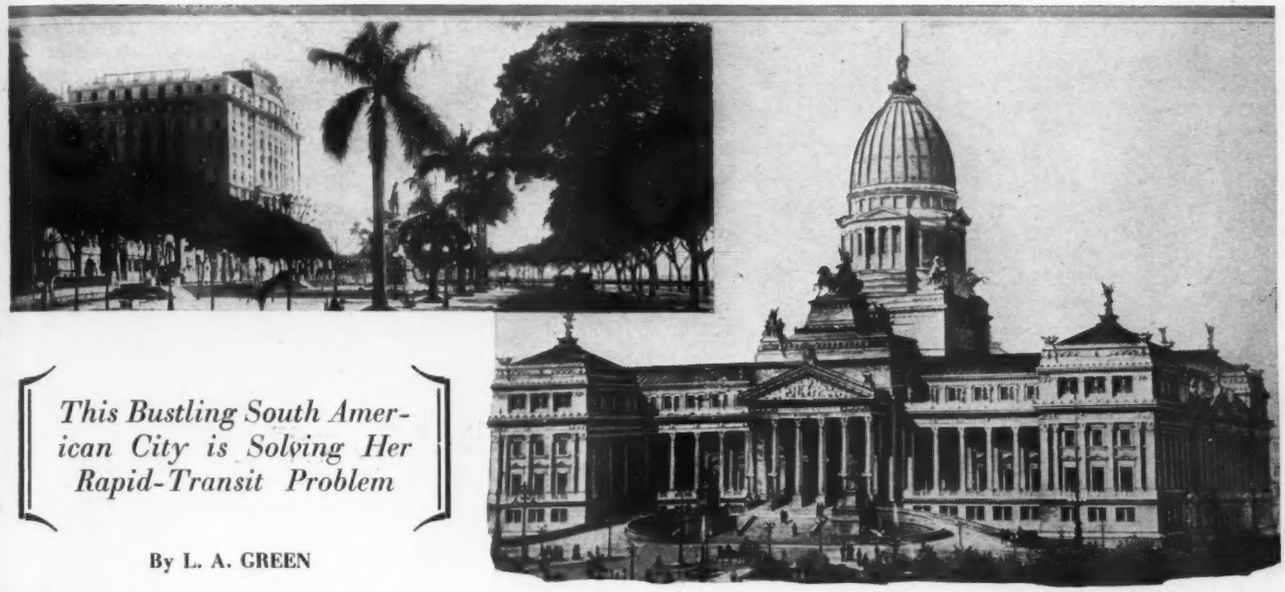
According to the latest compilation of Lloyd's Register of Shipping, the United States has advanced since 1914 from the seventh to the third place in the shipbuilding activities of the world.



Ewing Galloway.

How the famous Jones Well No. 1, in Oklahoma, looked last December when it was causing a great deal of trouble.

Buenos Aires Has New Subway



This Bustling South American City is Solving Her Rapid-Transit Problem

By L. A. GREEN

Keystone View Company
National Capitol of Argentina.

BUENOS Aires is to Argentina what New York City is to the United States—it is all that and more, because Buenos Aires is the capital of the country. That Buenos Aires is an extremely wealthy metropolitan center is manifest everywhere throughout the broad expanse of that foremost of South American cities. Abundant funds and architectural opulence have given her an outward expression that is distinctly characteristic of the place—combining as it does the spirit of Old Spain with an atmosphere typical of modern American progress.

Buenos Aires has grown up on the outskirts of that far-flung section of the country known as the *pampas*, and is situated on the banks of the Rio de la Plata where this tremendously prosperous metropolis serves as "the mouth of the horn-of-plenty from which flow into the waiting vessels of the world the riches of the agricultural and pastoral hinterlands of this fruitful country."

How Buenos Aires has attained to her present eminence is plainly indicated by records that reveal that the community in 1650 was composed of approximately 400 houses and had a population of about 4,000. By 1864, there were living within the expanding limits of the city in the neighborhood of 140,000 persons, and by 1900 the number of inhabitants had been augmented to 800,000. During the early part of the twentieth century, Buenos Aires initiated the era of development which has made her the thoroughly modern city that she is today. The census of 1914 showed she possessed 1,576,597 citizens; and in 1928 her estimated population had swelled to 2,078,733. At the present time, Buenos Aires is larger in area than either Paris, Berlin, or Vienna; and, based upon the people within her gates, she can fittingly be compared with Philadelphia.

A booklet prepared by the International Telephone & Telegraph Corporation has this to say for Buenos Aires: "The city is as cosmopolitan and varied as is New York, and even more so, for this metropolis of South America is the seat of national government as well as the industrial, commercial, social, and cultural center of the nation. There the president of the country lives and all the activities of the state government are carried on. To this city come many of the famous artists of the world to perform before the appreciative Argentines: to this city are brought harvests of grain to be measured and sold.

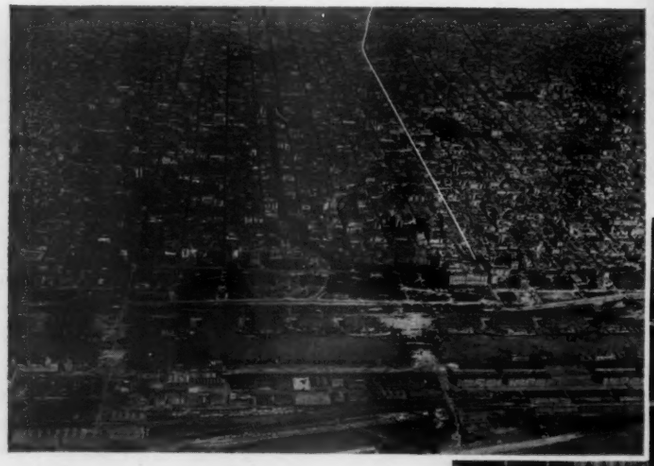
"In the modern slaughter houses of Buenos Aires great herds of livestock from the *pampas* are slaughtered, chilled, and stored in cold-storage houses awaiting shipment to all parts of the world. Exports are shipped, imports are received and distributed. Vessels of more than 20,000 tons make their way right up the river to the city and berth at splendid docks. The passengers step ashore in perfect comfort while their baggage is unloaded by the finest cargo-handling devices. In addition, there are along the harbor huge warehouses and grain elevators, many with a capacity of 1,000,000 bushels. The granaries hold twice that amount of grain in sacks."

Large building in center is Buenos Aires' new post office. Small circle at right is approximately above the downtown terminal of the subway.

European costumers and jewelers have their branches on the boulevards of Buenos Aires; and on all sides one finds shops containing the best and the finest of the products of looms and factories the world over. The citizens of Buenos Aires are fond of diversions and sports of every description, and there are ample opportunities for self-expression in the choice of these. The land has a distinctive lure and fascination, and these make a strong appeal not only to her own people but to visitors from afar. The city and the surrounding countryside have a background of romantic history combined with a vibrant life that is essentially of today.

As in the case of expanding

communities elsewhere, the growth of Buenos Aires has forced more and more of the populace to seek homes and living quarters farther and farther from the center of the municipality. This has brought in its train the need of providing means of bringing to the business sections of the city daily a great number of people and, conversely, carrying them back to the outlying districts or suburbs at the end of their day's labor. The magnitude of this movement, especially of the working population, has led to the development of a subway system adequate to meet the demands. The urban population of more than 2,000,000 souls, plus the notably large group of suburbanites employed in the city and increasing in a marked measure from year to year, has, for some time past, taxed existing traffic facilities to the utmost.



Left—Air view of downtown section of Buenos Aires. White line indicates route of the Lacroze Subway.

Right—Part of city at outer end of the subway, with route marked by white line.

Bottom—Buenos Aires' tree-lined Avenida de Mayo. Traffic follows the London custom and keeps to the left.

Keystone View Company

The construction of subways has been all too long delayed, and in these circumstances the completion of the Lacroze Subway provides a degree of relief that can be appreciated only by those who have to travel daily to and from the city during rush-hour periods. Owing to the urgency of the situation, the authorities showed wisdom in awarding the contract to Messrs. Dwight P. Robinson & Company, a division of the United Engineers & Constructors, Inc., which is thoroughly qualified by experience to deal expeditiously and efficiently with large undertakings such as this job represents.

The new subway has a length of 5.8 miles and extends from the Lacroze Station at the Central Buenos Aires Railway Terminal through the fashionable shopping center and the financial district to Calle Florida, which is not far from the waterfront. Between the terminal points are ten stations—twelve in all. With the exception of 2.2 miles, which was built by open-cut work, the line was constructed by tunneling.

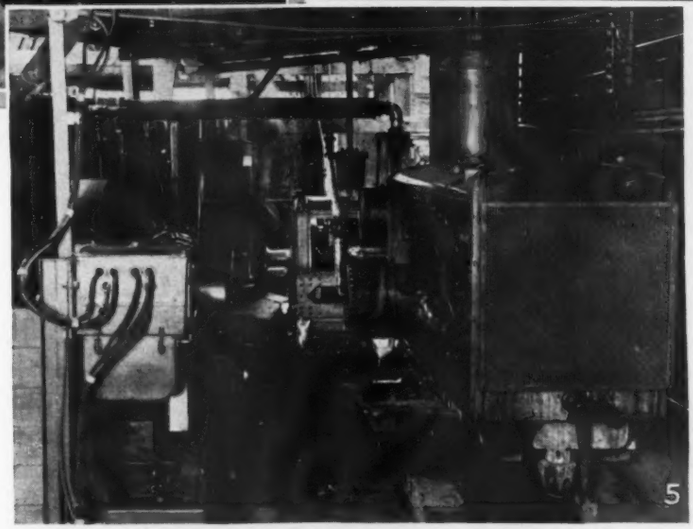
Most of the work is now completed. In fact, the stretch between the Lacroze and the Callao stations—a matter of about 4¼ miles—is already in operation. This part of the subway was officially opened to traffic on October 18, 1930, only twenty months after the project was taken in hand. This splendid performance, especially noteworthy in a country where undertakings of this sort are not everyday affairs, is attributed both to the efficient organization of all the forces and to the up-to-date machinery and equipment used throughout.

The finished section involved both open-cut and tunneling operations, while the section now nearing completion between the Callao Station and the downtown terminal is all tunnel. The entire work has necessitated the removal of 975,000 cubic yards of material —375,000 cubic yards in tunnel driving and 600,000 cubic yards in excavating the open cuts. A total of 175,000 cubic yards of concrete and 11,200 long tons of steel have been required in the construction of the subway.

While on the subject of materials, it might be interesting to note the sources from which they were drawn, because they indicate how far afield the builder went for the supplies and equipment needed to execute the contract. Uruguay furnished the stone and sand; from the United States came steel and reinforcing iron, wood for forms and timbering, copper wire, construction machinery, substation equipment, etc.; Germany and England sent tile; and the latter country also shipped cement, copper wire, rolling stock, and signal equipment. The ties are a native product. And how truly international is the character of the project is further emphasized by the fact that at one time as many as 35 different nationalities were represented on the company's payroll.

In the case of the open cuts, gas-air shovels were used to do the excavating wherever extremely hard earth was encountered, and the spoils were loaded into waiting trucks by clam-shell buckets. In the tunnel sections the excavating was done with No. 57 and No. 157 pneumatic diggers; and so effectively did these machines do their work that the tunnel drivers were always able to keep ahead of the timbering gangs.

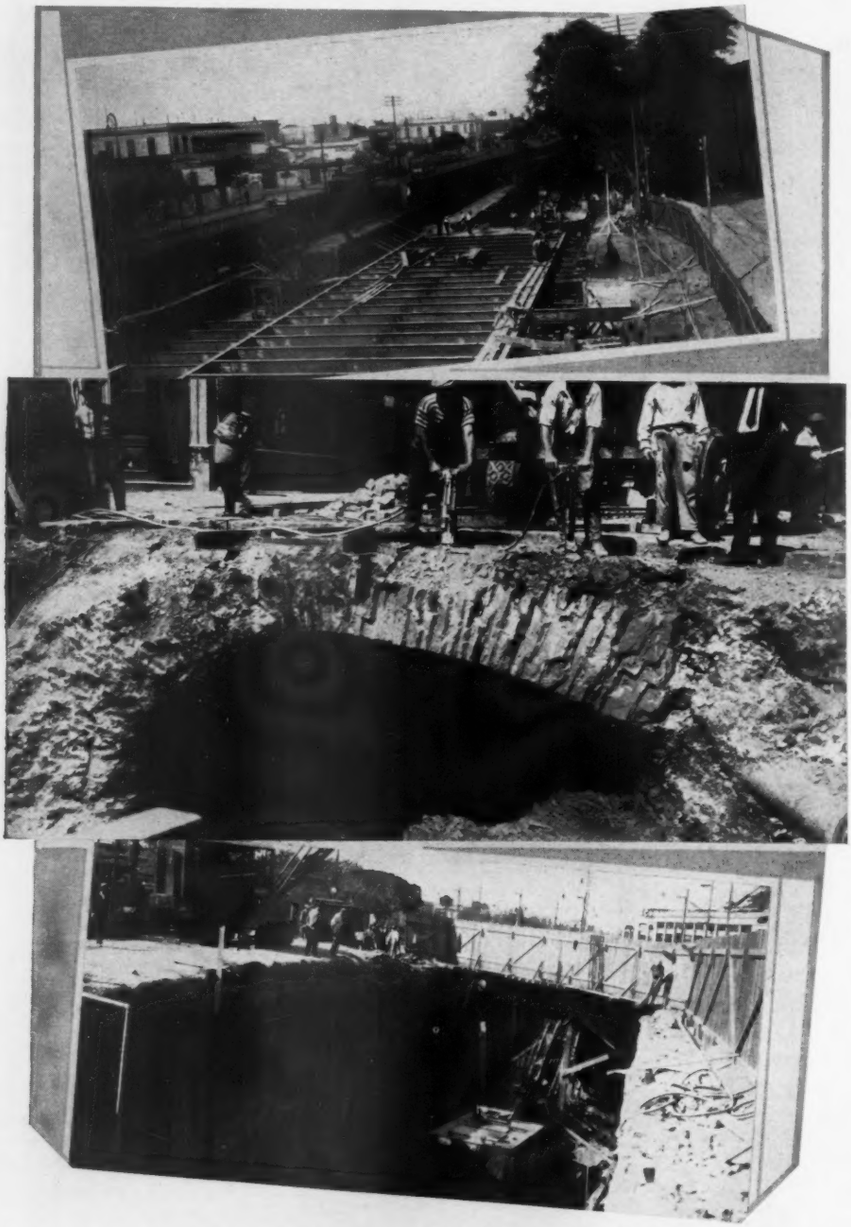
The method of advancing the tunnel was, generally, as follows: First the arch was cut



1—Air-operated wood borers of the CCW type preparing special timbers for the subway. 2—Pneumatic spades were found very helpful at some of the tunnel headings. 3—Joining tunnel roof beams with a 6A riveting hammer. 4—Forming light timber sets for the tunnel with air-driven safety saws. 5—An ER-1 stationary unit and a 10x8-inch Type 20 portable compressor provided some of the air required to operate the pneumatic equipment on the subway job.

and timbers placed resting on a sill which, in turn, rested on the lower tunnel section. Enough earth was then removed from the lower section to permit the setting up of vertical supporting timbers far enough away from the side walls so that the concrete footings and walls could be poured without interfering with the arch timbering. Concrete buggies, running on 2-inch flat planking laid on top of the sill, served to deliver and to place the concrete. Next the arch forms were erected and concrete deposited behind them by Ransome concrete placers. Thus it was possible to excavate, timber, and line 1,722.5 feet of double-section tunnel in 96 days. This was a record advance, and involved the removal of 40,800 cubic yards of earth and the placing of 10,080 cubic yards of concrete, or 425 cubic yards of earth and 105 cubic yards of concrete daily.

Where the ground was stable enough to permit it, the procedure was reversed—that is, the arch was not cut until after the lower tunnel section had been excavated, the timbers set, and the temporary flooring for the arch placed against the flat roof. This to some extent lessened the cost of removing the arch section. The method of timbering proved thoroughly satisfactory—hardly any difficulty being experienced with cave-ins.



Top—Roof beams in place over an open-cut section. Center—Destroying an old brick culvert along the tunnel route with air-driven CC-45 paving breakers. Bottom—Method used in open-cut excavation that permitted normal cross-street traffic.

Most of the concrete was provided by a central mixing plant that was capable of producing 550 cubic yards in eight hours. The material was delivered below ground by chutes and was either hauled to the working sites by the cars already referred to or was dumped into the air-operated Ransome concrete placers.

Air for the pneumatic equipment on the job was supplied by ten 10x8-inch Type 20 gasoline-engine-driven portable compressors. Besides the clay diggers and concrete placers already mentioned, this equipment included riveting hammers, safety saws, wood borers, "Utility" hoists and paving breakers. These were needed to break up an arch that blocked the right of way. In this connection it might be added that sewers, underground mains, cables, etc., not indicated on the city maps, caused the excavators considerable trouble.

The subway has been designed for both passenger and freight traffic, and is large enough to take the biggest car entering the Central Railway Terminal. With the exception of the Lacroze Station, which is at the terminal and can accommodate thirteen cars, the subway stations are built for 8-car trains. The cars are of steel, about 55 feet long and 10 feet 2½ inches wide, and each weighs 72,000 pounds. They are said to be the lightest yet constructed for a carrying capacity of more than 200 passengers each.

In order to deaden noise, the walls and roofs of the cars are lined with cork, the springs are provided with rubber shock absorbers, and the truck is insulated from the car body by strips of balata on the truck bolsters. And so that the operation of the trains may be as safe as it is humanly possible to make it, the cars are equipped with numerous ingenious devices. Each car has a trip mechanism that functions when it overruns a signal set at "danger". There is a button on the control lever that must be kept pressed by the motorman all the time the train is in motion. This button, if released, automatically cuts off the power and applies the brakes—a precautionary measure intended to prevent accident should the engineer become unconscious or incapacitated for any reason. The doors are opened and closed automatically; and a train cannot be started until all are closed. They can, however, be opened otherwise so as to enable passengers to leave a train in an emergency. After a stop, and before he can continue the run, the motorman must build up sufficient air pressure in the train line to enable him again to apply the brakes. The air pressure used is at 7 atmospheres. Coupling of the cars is likewise effected automatically—that is, the air and the electric connections are made without the need of men endangering their lives by going between cars to do this.

Each coach is fitted with two 125-hp. motors in one truck—the other truck being a trailer. This arrangement permits changing the power truck with a minimum loss of time. Direct current at 575 volts is utilized, and most of this is supplied by the subway company's own power station, at Paternal, which is equipped with two 7,000-kw. turbines. A certain amount of additional power, however, is required, and this power is purchased from the Chade Power Company. The electro-pneumatic controls under the cars are operated from the cabs with current at 32 volts, thus obviating the need of carrying the 575-volt current, that might prove dan-

gerous, inside the cars.

The stations are finished in white tile with a pleasing colored-tile trim—no two stations being decorated alike. The platforms are commodious, and in the case of the tunnel stations both the up- and the downtown platforms are reached from either side of the street by a mezzanine floor just below street level. Escalators connect the mezzanine with the platforms. In the open-cut stations, access to each platform is had by a wide stairway. No passenger tickets are issued on the line; fares are collected by the turnstile method. The Lacroze Subway is, therefore, the first public transportation system in Buenos Aires to abolish the ticket nuisance.

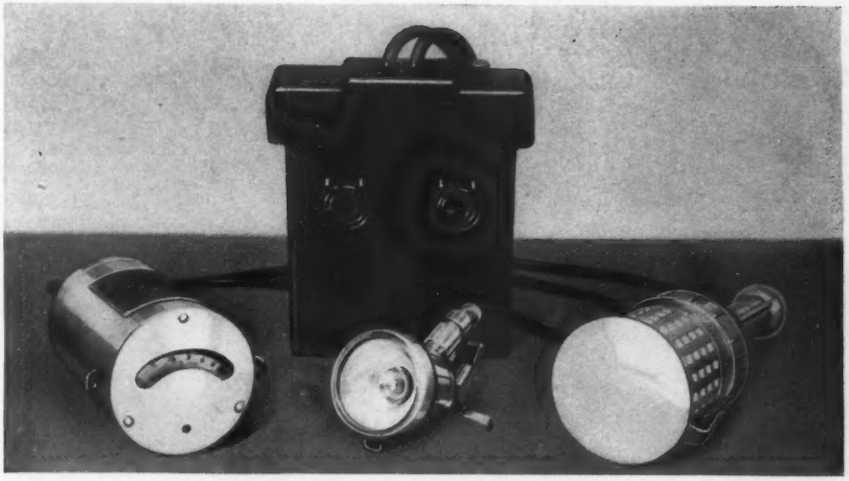
The Argentine organization formed by the Dwight P. Robinson & Company to execute the contract was headed by Mr. I. W. McConnell, vice-president, who was ably seconded by Mr. J. L. Lytel as general manager. Work on the tunnel was carried on in two divisions—the western end being superintended by Mr. W. W. Taylor and the eastern end by Mr. B. S. Thayer. Two other figures familiar in American subway and tunnel circles were actively engaged on this job. We refer to Mr. "Dick" Redwood and Mr. George Naill in direct charge, respectively, of the tunneling and the open-cut operations. The care of the mechanical equipment and the extensive machine shops required for so large an undertaking was entrusted to Mr. H. L. Schage, traffic manager, assisted by Mr. T. J. Morrison, master mechanic. Mr. Schage is now the acting manager of that part of the line in service.

AUTOMATIC LIGHTHOUSE GIVES RECORD SERVICE

MOLOKINI Lighthouse, situated near Maui Island in the Hawaiian group, has burned brightly every night for nineteen years and eight months despite the fact that the mechanism is automatic and no keeper lives at that station. As the light flashes every three seconds, the apparatus has, without attention, produced more than 207,000,000 flashes during that long interval, according to the United States Lighthouse Service.

Automatic lights such as this burn compressed acetylene gas, and, under most conditions, are kept supplied with tanks containing sufficient gas for a year's operation. Lighthouse tenders visit the stations periodically—usually not more than twice every twelve months—for the purpose of installing new tanks and examining the equipment. The exceptional record made by the Molokini light is in part due to the fact that it has been the practice every four years to put up a new lantern and flasher and to take the old ones for overhauling to the nearest lighthouse depot maintained by the service.

Because of the reliability and the regularity with which lights of this description can be counted upon to function, it has been possible to set them up at extremely remote and isolated points where human beings would be unwilling to live and thus measurably to increase aids to navigation.



From left to right—The meter case, the electric cap lamp with the storage battery back of it, and the detector head.

IMPROVED METHANE DETECTOR

SEVERAL years ago there was described in these pages an electrical methane detector developed by the Union Carbide Company. Since then that instrument has been modified and, in its present improved form, has recently received the endorsement of the United States Bureau of Mines.

The new indicator is self-contained and portable, and consists of a detector head, a milliammeter, a storage battery, and an electric cap lamp. The detector head is small, and its louver-type bonnet permits free circulation of the air through screens to a noncatalytic filament. This filament is in the top of the bonnet so that a very thin stratum of fire damp close to the roof of a coal mine will not escape it. The storage battery is of sufficient capacity to operate the detector and the cap lamp continuously for five hours. An extra battery goes with the outfit and constitutes a spare.

By an arrangement of straps and a miner's battery belt, the entire equipment is carried securely and comfortably by the inspector who is not hindered by it even when he has to crawl or climb in making his rounds through a mine. The legible scale on top of the meter hung on his chest is fully illumined by the lamp on the front of his cap and is always within range of his eyes. For the testing of seams up to 10 feet in height the 5-foot length of flexible, rubber-jacketed cable provided is ample; and so that the inspector can readily examine the air in pockets in the roof, reach over "falls" and into other inaccessible places where methane is likely to accumulate, the detector can be fastened to a pole.

To operate the instrument it is only necessary to set the meter needle at zero; to turn on the control switch; and then to hold the head, containing the sensitive filament, aloft here and there wherever it is desired to test for methane. If fire damp be present, the needle instantly moves up the scale and indicates the percentage of the noxious gas in the air. All guesswork is eliminated by the use of the instrument, which gives readings from 0.1 per cent to a point slightly beyond the lower limit of flammability.

The methane detector in service.

WORLD'S LARGEST CRANE

THE huge crane which has been installed for stand-by service at the Lake Ontario entrance to the Welland Canal surpasses in size anything so far built in the shape of stationary, movable, or floating cranes. It has a vertical lifting capacity of 500 tons and is designed, in case of emergency, to handle the great lock gates at Port Weller and at Thorold. It can, however, be used for other work, as it is equipped with a boom that has a reach of 125 feet and can lift a load of 125 tons.

Mounted on a craft 90 feet long and 66 feet wide, the crane towers 110 feet above the bottom of the vessel. To counterbalance the combined weight of the crane and its load, there is required 1,000 tons of permanent ballast as well as a quantity of water ballast which is shifted, as needed, from one to another of eight tanks. The crane is electrically controlled; and it was built at Collingwood, Ont., at a cost of $1,500,000.

Quicksilver Mining in the United States

By C. N. SCHUETTE

Left—Where the top of a stope in an Arizona quicksilver mine broke through at the surface.

Right—Hauling wood to the furnaces of a Texas mine. The wood costs $10 a cord.

Bottom—In the foreground is the glory hole of an Oregon quicksilver mine.

THE story of quicksilver mining in the United States reflects many phases of the history and progress of the Union. United States production began at the New Almaden Mine in California in 1850, just in time to supply quicksilver for amalgamation in the early placer gold mining that followed the rush of '49.

By 1865 several quicksilver mines were in operation and supplied the liquid metal for gold-quartz mine operations and for hydraulic gold mining, which began about 1860. The pan-amalgamation process, invented in 1868 and used largely in the production of the wealth of the Comstock lode, called for large amounts of quicksilver at a later date. This wealth, produced with the help of quicksilver from California, and coming when it did, practically decided the fortunes of the Republic in the Civil War.

Stimulated by great demand and high prices, a boom in quicksilver mining was inevitable. In 1877 more than 79,000 flasks, each holding 75 pounds of quicksilver, were produced in the United States. This enormous output was greatly in excess of that needed for home consumption, and the surplus—some 30,000 to 50,000 flasks annually for a period of ten years—was exported to the gold- and the silver-mining regions of the entire world. Thus California quicksilver broke the monopoly of the world quicksilver supply held at that time by the House of Rothchild of London.

Competition lowered prices; high-grade ore gave out; and production declined during the next few decades. Amalgamation was used less and less, especially after the cyanide process for leaching gold ores was introduced and other applications were found for the bulk of the quicksilver production. Before 1890, amalgamation no doubt made the heaviest demand on the stock; but by that time amalgamation was taking less and less and the requirements in the United States around 1890 were probably as follows:

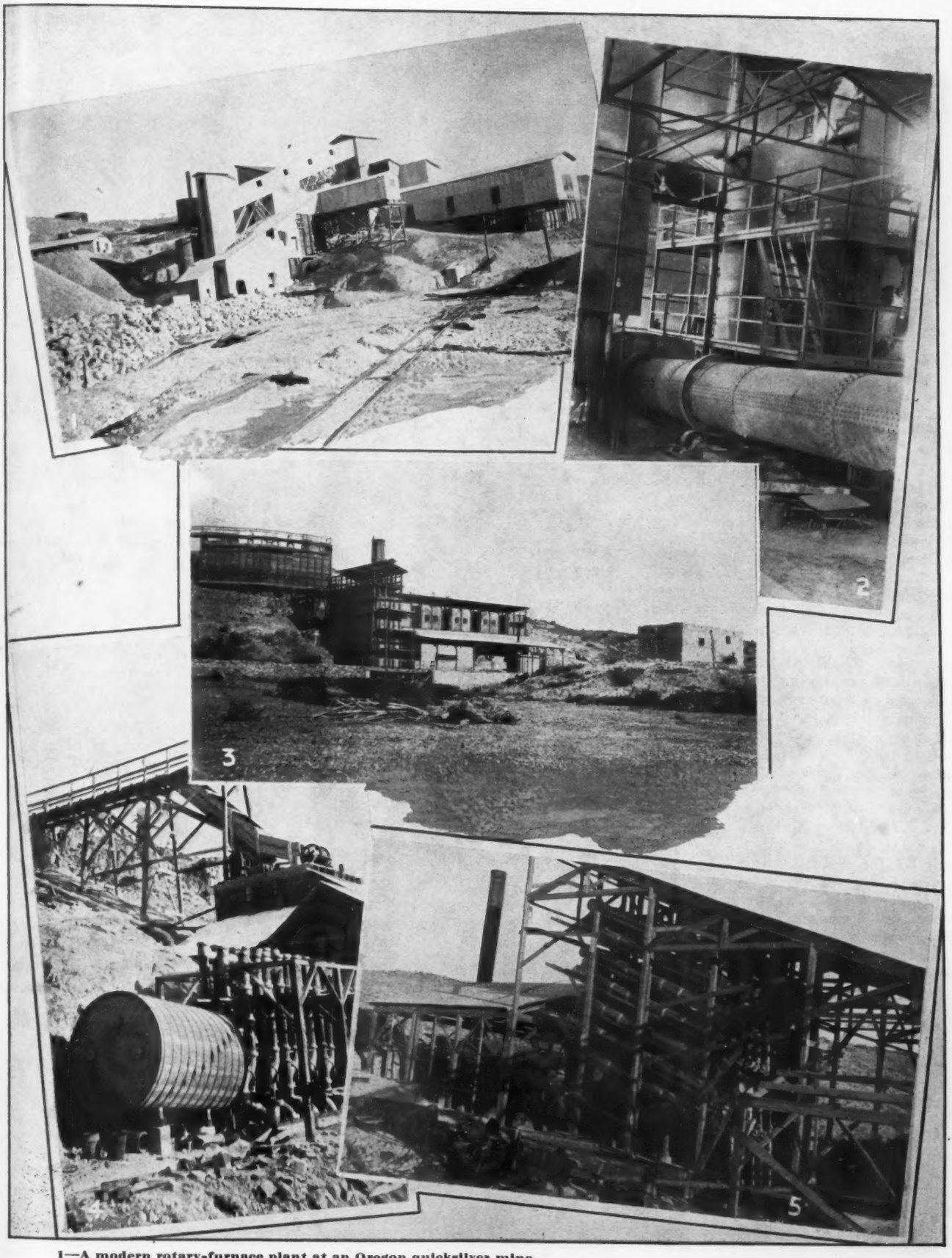
	Flasks per Year
Amalgamation	10,000
Manufacture of vermilion	8,000
Fulminate and drugs	2,500
Other uses	1,000
Total	21,500

Since then amalgamation has been used still less, and industrial demands have increased until, today, consumption in years of good business activity is probably about as follows:

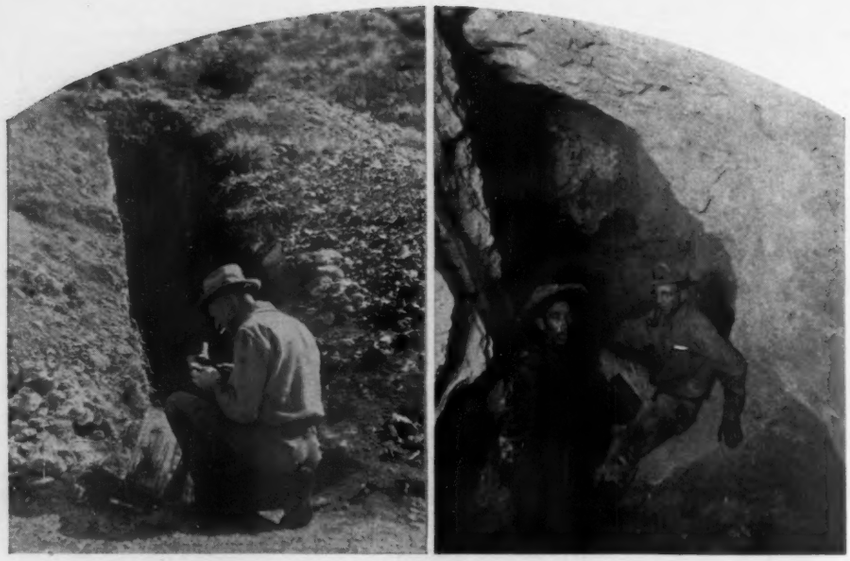
	Flasks per Year
Amalgamation	500
Manufacture of vermilion	2,500
Fulminate and drugs	20,000
Other industrial, chemical and electrical uses	12,000
Total	35,000

In the 80 years since 1850 about 2,500,000 flasks of quicksilver have been produced in seven states and in quantities about as follows:

QUICKSILVER is the only metal that is fluid at normal temperatures; and, because of this and other characteristics, mercury has as many as a thousand different uses. The ore is the source of rouge for cheeks and lips and also of the reflecting coating of mirrors. Mercury serves as an insecticide, as a preservative, as a medicament, as an ingredient in the printing of fabrics, as a pigment, and in certain antifouling paints for ships' bottoms. It plays a part in the radio industry and in neon lights and other electrical devices; and it performs valuable services in control and measuring instruments of numerous sorts. As a detonator for explosives it is distinctly superior to other agencies; and a large field of usefulness is offered in the potential further development of the mercury boiler and turbine.



1—A modern rotary-furnace plant at an Oregon quicksilver mine.
2—A rotary kiln in the foreground and a Herreshoff furnace in the background at the right.
3—Small Scott furnace with brick condensers at a Texas mine.
4—Tile-pipe condenser at the Antelope Springs Mine.
5—Tile-pipe condenser in which the pipes are inclined from the horizontal.



**Left—Prospector panning for cinnabar in a surface cut.
Right—Underground in the stope of a Texas quicksilver mine.**

	Flasks
California	2,333,000
Texas	116,000
Nevada	25,000
Oregon	16,000
Washington	5,000
Utah	3,000
Arizona	2,000
Total	2,500,000

Just before the World War, quicksilver mining was at low ebb in the United States. War demand for mercuric fulminate, calomel, and corrosive sublimate was large; the price quadrupled; and quicksilver-mine operators hurried to work the low-grade ore that previously could not be treated at a profit.

By the end of the war those low-grade reserves were greatly depleted. Relatively little new ore had been developed due to the scarcity of labor and the uncertainty of the duration of the war and, therefore, of the high price. After that conflict the price fell to below pre-war levels, and in 1922 only one or two quicksilver mines were left in operation. Then a substantial protective tariff encouraged the industry to carry on, and still later it was further aided when the cartel of European producers was formed to hold up the price. Of late the high price has been well sustained, and it bids fair to hold. This sustained high price over a number of years has stimulated the search for new mines and for new ore bodies in the old mines. This brings us to the subject of the occurrence of quicksilver ore bodies in the United States.

In California, most of the quicksilver ore bodies are found in the Franciscan strata—a series of sandstones, shales, and cherts, probably Jurassic in age, that is exposed over a large area of California and extends into Oregon and Washington. After those sedimentary rocks were deposited in Jurassic times, there occurred a period of volcanic activity during which the Franciscan strata were intruded by great masses of molten magma which solidified to peridotite. These intrusions shattered the rock strata through which they pushed their way and thus left planes of weakness around the borders of the large intrusive masses, or laccoliths of peridotite.

A period of erosion followed, and then more sediments were deposited in Cretaceous and later times. Other intervals of erosion followed, and today we find large areas of Franciscan rocks exposed on the present surface. In the various periods of erosion when the peridotite intrusives in the Franciscan strata were bared to the surface they absorbed water and were altered into the serpentine which the geologist finds today. In altering from peridotite to serpentine, the volume of the altering rock mass increased and the attending pressure further shattered the contact rocks. Thus there were formed large zones of porous rock masses that were later to become the receptacle rock of the ore bodies.

At a much later geologic time than the Jurassic age and probably as late as the Pliocene or even Pleistocene—the age before the present, the region was again subjected to volcanic activity during which basalts and similar igneous rocks intruded the sedimentaries along the same general planes of weakness previously developed in them by the peridotite intrusions of Jurassic time. The deposition of the cinnabar, the ore of quicksilver, seems to have been the final phase of this latter intrusion.

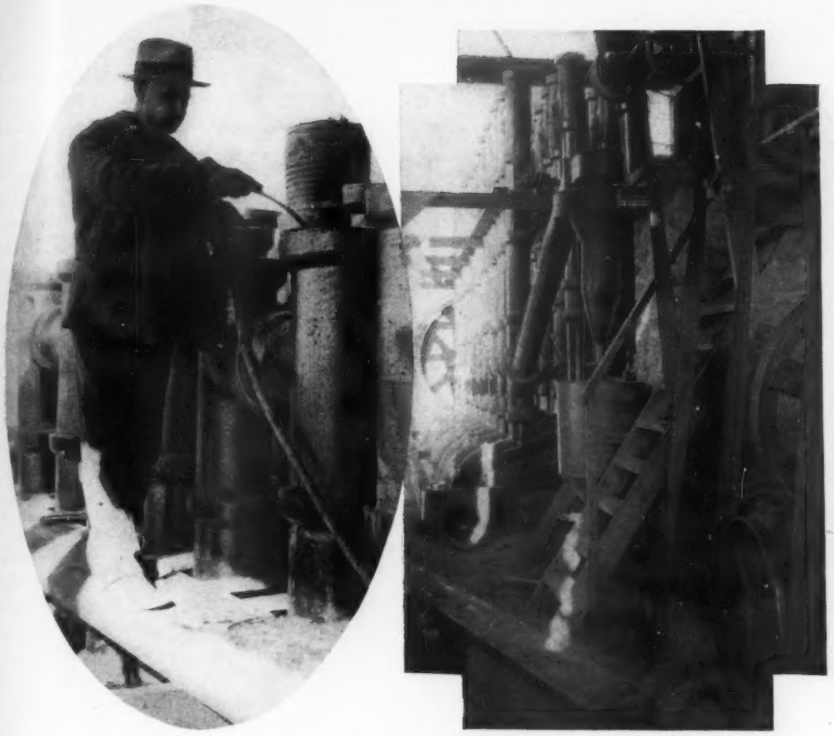
The earth movements accompanying the periods of volcanic activity formed fault gouges in the shattered border rocks along the planes of weakness. Quicksilver-bearing solutions coming from the molten magma below ascended through the shattered rock mass and deposited their load of cinnabar in concentrated form when and where they were stopped or trapped by the impervious fault gouges.

A good example of this is the New Idria Mine in San Benito County, California, the largest producer at the present time. There the zone of shattered rock on the contact of the serpentine and the sandstone is from 60 to 100 feet thick, more than 1,000 feet in length, and has been mined to a depth of 1,400 feet below the outcrop. The fault gouges under which the ore formed are generally near the hanging wall of the shattered zone, but others have been found at various distances towards the footwall of the shattered zone which dips some 60° from the horizontal.

The exploration of such a large zone of shattered and possibly ore-bearing ground is no small problem, and has been accomplished in recent years at this mine by long-hole drilling. It is a new development in quicksilver mining and merits a brief description. This method of exploration was inaugurated in 1927; and so far some 9,000 feet of hole have been drilled. The longest hole to date reached 228 feet while the average length of hole is 100 feet. Usually up-holes are drilled from 8° to 50° above horizontal, though down-holes are also drilled.

The machine in service is of the Ingersoll-Rand S-80 type—a heavy, independently rotated drifter. Water at a pressure of 100 pounds is used to clear the hole of sludge. The water is fed through an auxiliary water

An Ingersoll-Rand portable compressor at the Antelope Springs Mine near Lovelock, Nev.



Left—The clean-up: washing quicksilver out of condenser pipes. Right—A condenser equipped with a dust-collecting "Sirocco" cyclone.

swivel attached to the head of the machine. The drill gages range from 3¼-inch standard cross-bit starters down to 1¾-inch steel, while 1¼-inch round steel is used in 3-, 6-, 9-, and 12-foot lengths joined with 6-inch left-hand sleeve couplings. The drill is supported on a bar between two columns. Fishing tools made of 1½-inch pipe serve to recover the rods when a break occurs, though this is rare. The sludge from drilling is caught below the drill hole in a split-pipe launder and runs into a carbide can. This sludge is panned to determine the cinnabar content of the rock being drilled. Results from later mining operations have checked the indications gained by panning.

One machineman and one helper constitute the crew. From 25 to 30 feet of hole is a day's work, and a bonus of 10 cents is paid for every foot drilled over 30 feet. The cost per foot of hole is about 85 cents, including the write-off for the machine and auxiliary equipment which cost some $1800.

New ore as well as extensions of known ore bodies have been found by this method. If ore is discovered, the cost of exploring a given block of ground by drilling followed by drifting and crosscutting is about half that of exploring the ground by drifts and crosscuts alone. Drifting is done with R-12 "Jackhamer" drills, and costs from $7 to $9 per foot. Stoping is done with CC-11 Stopehamers. Steel is sharpened with a No. 5 sharpener, and compressed air is supplied by three Ingersoll-Rand Imperial Type 10 compressors, each with a capacity of 600 cubic feet per minute.

Getting back to ore occurrence, in Texas the greatest production of quicksilver has come from cinnabar ore deposited in flat-lying, fractured, cretaceous limestones lying just under an impervious cap of clay shales. In other mines, fractured igneous rock and shaly limestones carry the ore under a cap of denser shale layers. Exploring is done by sinking shafts to the ore-bearing horizon and then drifting and crosscutting in search for the ore. Diamond drilling has also been used with success in this field. In the recently developed Antelope Springs district near Lovelock, Nev., the occurrence of the cinnabar is similar, although the fractured limestones with their cap shales dip more steeply than in the Texas field.

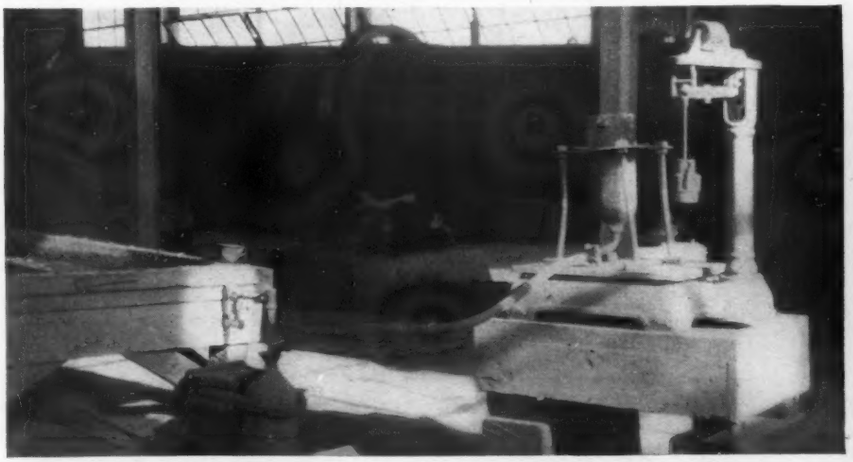
It is largely due to the portable compressor that new districts are being developed so rapidly, compared with the much slower progress made in the days of hand mining. Another aid is the small compressed-air hoist as opposed to the hand windlass. In general, the automobile, canned food, and compressed air have had a large part in the development of new quicksilver mines throughout the West in recent years, and Nevada, Oregon, Washington, and Arizona have been added to the states of Texas and California as substantial producers of the liquid metal.

The beneficiation of quicksilver ore is a relatively simple process. The ore is heated to a red or roasting heat in a furnace. The sulphur of the cinnabar, HgS, combines with the oxygen of the excess air in the furnace gases to form sulphur dioxide, and the quicksilver is set free as a vapor. The furnace gases containing this vapor are carried through and cooled in a condenser. The condensed mercury vapor is caught in the condenser while the gases pass out by way of a stack.

The preparation of the ore for this treatment consists merely of crushing it to pass a 2-inch screen. This crushed ore is fed directly to the furnace. Three types of furnaces are in general use in the United States. The old Scott furnace, developed at New Almaden, is a shaft furnace arranged for treating fine ores by an ingenious arrangement of inclined shelves over which the ore moves downward while the gases of combustion move upward under them. In appearance this furnace is like a tall brick tower. Most of the quicksilver produced in the United States has come from such furnaces, but of late mechanical furnaces are more in favor.

Two general types of mechanical furnaces are used: the rotary kiln, similar to the cement kiln, and the Herreshoff hearth roasting furnace. Mechanical furnaces make dust—the kiln by its rotation and the Herreshoff by the drop of the ore from hearth to hearth. This dust must be removed from the furnace gases before they enter the condenser system, generally consisting of a series of cooling pipes of metal or glazed stoneware. If the dust be not removed it not only mixes with the condensed quicksilver but also chokes the pipes, necessitating a shutdown for cleaning.

Dust is removed from the gases by passing them through dust collectors, such as Cottrell precipitators or cyclones of various types. The cleaned gases—and they must be cleaned while hot enough to prevent condensation of the contained quicksilver vapor—then pass to the condensing pipes. In these the



Weighing and bottling apparatus at a Nevada quicksilver mine.

quicksilver condenses first at a temperature depending upon the grade of the ore. Farther along, the acid water formed by the SO_2 and the water vapor of the gases is condensed. For this reason the condenser pipes must be made of an acid-resisting material. Natural draft sometimes serves to move the gases through the furnace and condensers; but more often than otherwise the draft is induced by mechanical exhausters which must operate either on the hot gases coming from the furnace or on the acid-laden gases nearer the stack.

Thus, while the process is relatively simple, careful design with due regard to the conditions to be met is essential in planning a quicksilver-reduction plant to give economical operation. The cost of such a plant varies in different localities from $500 to $1000 per ton-day capacity. If oil be used, the fuel consumption should be about 7 gallons per ton treated. The furnace removes the quicksilver contained in each ton of ore and transfers it to about ¾ ton of gases from which, in turn, the condenser serves to separate it. The quicksilver content of the gases, when treating low-grade ore, is less than ½ per cent by weight of the gas. This reduction process, giving a recovery of better than 95 per cent, is carried on at a cost ranging from 50 cents to $1.50 per ton and includes all operations, starting with run-of-mine ore and ending with the finished marketable product bottled in iron flasks each containing 76 pounds of quicksilver.

All quicksilver mines have their own reduction plants, as there are no custom smelters in this business. In size the plants may range from the prospector's retort that treats 100 pounds of ore daily to large plants having a number of mechanical furnaces treating up to 100 tons each per day.

In these days, 1 per cent ore—that is, ore containing 20 pounds of quicksilver per ton—is high-grade ore, and only a few of our mines can, by careful sorting, furnace some 15 to 30 tons of such ore per day. By far the larger part of our annual production comes from ore containing less than ½ per cent or 10 pounds of quicksilver per ton. The lower limit of ore that can be treated at a profit is 3-pound ore. At the present prices of around $100 per 76-pound flask, 3-pound ore is worth about $4 per ton. Only efficient operation can show a profit when mining such low-grade ore on a basis of 50 to 100 tons per day.

Production of quicksilver in the United States has been increasing since the dark days of the industry in 1922, but it is not yet sufficient to supply our home consumption. The difference between production and consumption is imported from Spain and Italy. Search for new mines is active, and if the price holds up, as it has every indication of doing, it may well be that the discovery of new mines or new ore in old mines will again enable the United States to meet her requirements of this important metal.

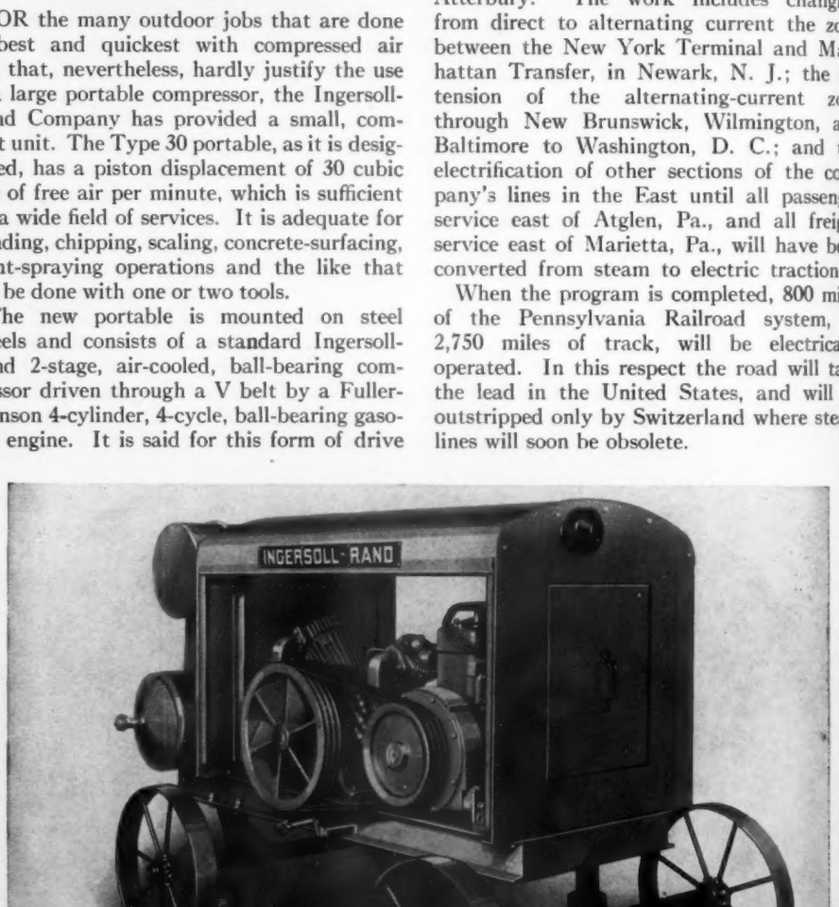
The gas industry of the United States is reputed to have spent $450,000,000 in 1929 in order to meet the steadily growing service demands.

Square-set stope in an old California quicksilver mine.

SMALL PORTABLE COMPRESSOR WITH WIDE FIELD OF USE

FOR the many outdoor jobs that are done best and quickest with compressed air and that, nevertheless, hardly justify the use of a large portable compressor, the Ingersoll-Rand Company has provided a small, compact unit. The Type 30 portable, as it is designated, has a piston displacement of 30 cubic feet of free air per minute, which is sufficient for a wide field of services. It is adequate for grinding, chipping, scaling, concrete-surfacing, paint-spraying operations and the like that can be done with one or two tools.

The new portable is mounted on steel wheels and consists of a standard Ingersoll-Rand 2-stage, air-cooled, ball-bearing compressor driven through a V belt by a Fuller-Johnson 4-cylinder, 4-cycle, ball-bearing gasoline engine. It is said for this form of drive that it permits both the engine and the compressor to run at their most economical speeds while at the same time making it possible to deliver more than the ordinary amount of air per gallon of gasoline. The fuel tank has a capacity of 12 gallons—more than enough for a day's continuous running. The air receiver is 16x40 inches, and is of approved design. Among the equipment carried are a finned copper-tube intercooler, air cleaners, and an automatic unloader and governor. All the operating parts are protected from dust and dirt by a steel housing with removable sides to permit easy access. In materials and workmanship the Type 30 is in all respects like the company's bigger models that have won recognition the world over.



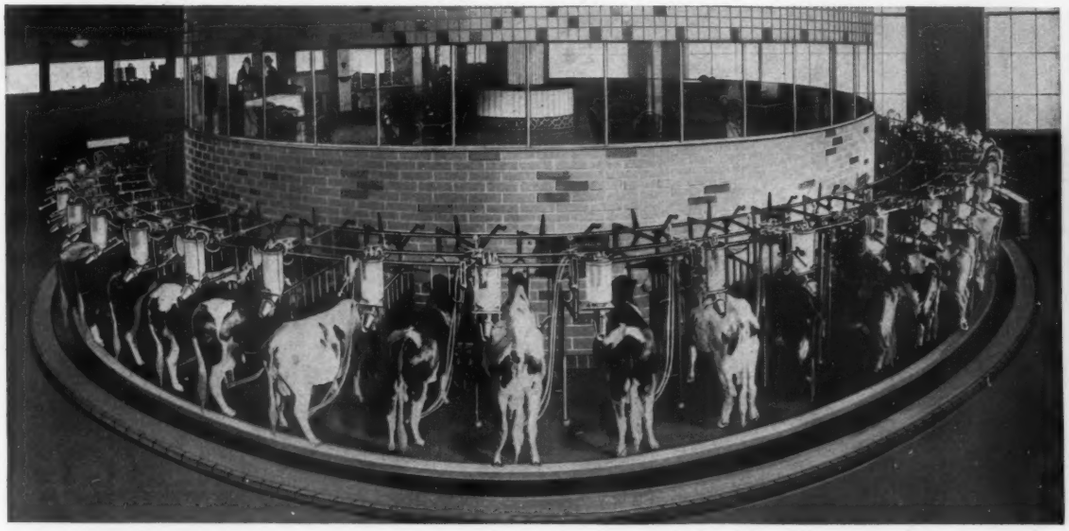
The new Ingersoll-Rand gasoline-driven compressor that has a capacity of 30 cubic feet of free air per minute.

PENNSYLVANIA RAILROAD ADDS TO ELECTRIC TRACKAGE

APPROXIMATELY 60,000,000 pounds of copper will be required by the Pennsylvania Railroad in the next two and a half years for the completion of its extensive program of electrification, as recently announced by the president of the road, Gen. W. W. Atterbury. The work includes changing from direct to alternating current the zone between the New York Terminal and Manhattan Transfer, in Newark, N. J.; the extension of the alternating-current zone through New Brunswick, Wilmington, and Baltimore to Washington, D. C.; and the electrification of other sections of the company's lines in the East until all passenger service east of Atglen, Pa., and all freight service east of Marietta, Pa., will have been converted from steam to electric traction.

When the program is completed, 800 miles of the Pennsylvania Railroad system, or 2,750 miles of track, will be electrically operated. In this respect the road will take the lead in the United States, and will be outstripped only by Switzerland where steam lines will soon be obsolete.

Milking on a Wholesale Scale by Machine



The Rotolactor at work on the Walker-Gordon Farm. It is the only milking machine of its kind, and accommodates 50 cows at a time.

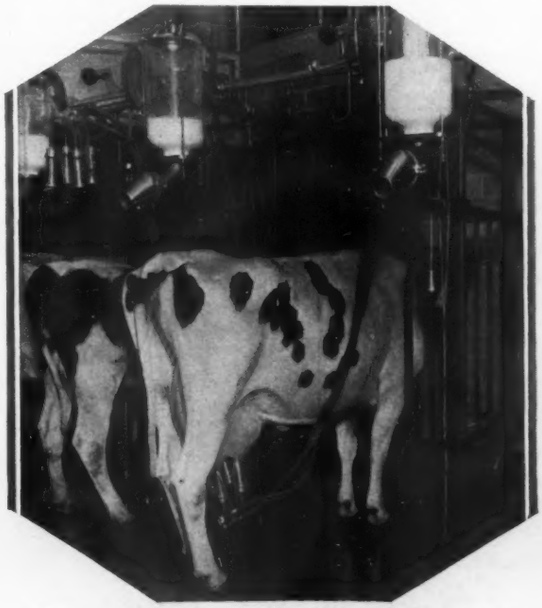
MASS production has struck the dairy industry. In proof of this there is published a picture showing 50 cows being milked mechanically at one time and in the brief span of 12½ minutes. And not only are these 50 bossies milked in this short interval in a strictly hygienic fashion, but they are washed and dried as well. This is something of an accomplishment, and is made possible by a rotary combine milker called the "Rotolactor".

The Rotolactor is the result of almost twoscore years of work in the Walker-Gordon Laboratories of the Borden Research Foundation, and is the invention of Henry W. Jeffers, president of the laboratories. Up to date but one machine of the kind has been used, and that is installed in a modern brick-and-tile structure on the Walker-Gordon Farm at Plainsboro, N. J. There, as many as 1,680 cows are milked three times every day by the Rotolactor, which is in the form of an electrically operated turntable, 60 feet in diameter. Around a 44-foot circular chamber on this platform are grouped 50 stalls with stanchions.

A long covered runway connects the barns with the building that houses the giant 30-ton milker, and as each cow, in turn, approaches the turntable she steps into the empty stall directly in front of her. Automatically the associate stanchion closes about her neck—the platform moving all the while and carrying her with her fellows slowly to the left where she receives a shower bath and is dried with blasts of warm air and otherwise prepared for milking to assure a thoroughly clean product. By the time these operations are completed, the animal has covered one-fourth the distance to be traveled, so that the elapsed milking time is actually less than ten minutes. Arriving at the point where she began her round trip, the stanchion is released without human agency and the cow is started on her unattended way back to the barn, an eighth of a mile distant.

The milking equipment consists of rotary vacuum pumps fastened to the underside of the turntable. These pumps are motor driven—electric current being drawn from a main power line through a trolley system. The pumps are connected by piping to a main vacuum line that encircles the platform and supplies each of the 50 milking units. Inserted in this line are two traps. These are designed to catch all foreign matter that may be entrained and automatically to shut off the supply of vacuum from the pumps at any time should the traps become filled with liquid. After each revolution of the turntable any liquid that may have accumulated in the traps is emptied. In this way the vacuum system is kept clean for its exacting service.

The milk from each cow is forced by suction into a glass jar overhead and is discharged into a weigh-can as soon as the Rotolactor has made a complete circle. In this way the yield from each cow is checked and tabulated before the milk is sent through sterile pipes to the filtering and bottling machines.



Close-up of one of the stalls, showing the general arrangement of the vacuum system.

One outstanding feature of the new milking machine is the means provided for regulating the pulsations of the vacuum cups so as to make for maximum production. Cows are known to be creatures of habit and will respond readily to regular treatment. In other words, a cow that is milked by the same person will yield more than one that is milked by different people. In the case of the Rotolactor, this uniformity of action on the part of all the units is assured by the electro-magnetic control of the pistons from central distributors obtaining current from a direct-connected motor-generator set. By causing first air and then vacuum in definite quantities to enter the vacuum cups it is possible to synchronize the 50 units both as to speed and pulsations.

The Rotolactor at the Walker-Gordon Farm is kept busy 21 hours of every day and in that time has to its credit 5,040 separate milkings—the quantity handled being sufficient to satisfy the wants of 30,000 babies.

Increased comfort will henceforth be insured all travelers on the Baltimore & Ohio Railroad's "Columbian" operating between Washington, D. C., and New York City. Each diner, club, observation, and chair car on this special train is to be equipped with an electrically operated air-conditioning unit that will permit ventilating it without the opening of windows—that is, without the admission of dust or smoke. The equipment is designed to give a complete change of air, whether a coach be standing or in motion, every two minutes and at any desired temperature.

Back-breaking hand-mucking, as here shown by George Z. Mellen, is rapidly being done away with by the use of scraper hoists.

PRODUCTION INCREASED BY AIR-CLAMPING

MODERN automatic milling machines, says A. C. Janke in *Modern Machine Shop*, have become so tremendously productive that their capacity is, in many instances, much greater than that of the men who run them. Production is limited either because the machine is idle while the operator is reloading its fixture or because the work can be milled faster than it can be loaded. In an effort to increase output, fixture design has been receiving more attention, and very gratifying results are apparent. The aim, of course, has primarily been to shorten the loading time by reducing the amount of manual work in the machine cycle. Many kinds of devices have contributed to this end; but perhaps the most interesting improvement is the application of the pneumatic cylinder to clamping.

A good example of the merits of air-clamping is offered by two automatic milling machines that are identical except for the number of parts held in the fixture and the method of clamping employed. The one is equipped for hand-clamping, handles four pieces at a time, and turns them out at the rate of .205 minute each. The other has a capacity of six pieces and turns them out at the rate of .16 minute each—the increase in production being entirely attributable to air-clamping. In the case of the latter, there are also not as many manual operations to be performed as when hand-clamping is used, so that the man at the machine can do his work with less fatigue.

The pneumatic clamping mechanism in consideration is not an integral part of the milling machine: it is a separate unit and is mounted on the machine table. It consists of a nest of vertical air cylinders which exert a downward pressure on the work—the movement of the lever that manipulates the fixture also applying or releasing, as the case may be, the necessary compressed air.

Indium is a rarity among metals, and so far only about a pound of it has been isolated from the ores containing it. What little of it has been used for experimental purposes has brought six times as much as platinum. The mineral is found in very small quantities in the residue of such ores as iron, aluminum, titanium, and silicon, and can be produced 99.9 per cent pure by electrolysis. It melts at a much lower temperature than tin, and is very soft and ductile.

Goodyear Compass (Cord) Endless Belt delivers maximum heavy-duty service

"no signs of wear—no stretch to speak of"

Of the hundreds of comments Goodyear has received on its revolutionary Compass (Cord) Endless Belt the following, from Mr. Charles Ford, Factory Superintendent, Kraftile Company, Niles, California, is typical:

"On July 16, 1929, we installed one of your 8-inch Goodyear Compass (Cord) Endless Belts on our 40 H.P. Ingersoll Rand Compressor. To date this belt has not given us the least trouble and has performed the heavy duty imposed upon it with no visible signs of wear and without any stretch to speak of."

The stout bias-cut envelope of the Goodyear Compass (Cord) Endless Belt takes surface wear from pulleys and idlers. The enclosed cords carry the load and maintain the tensions needed for the heaviest work. That is why this Goodyear belt delivers such nearly stretchless service on compressor drives. That is why it will cut your belting costs on other heavy duty drives.

All Goodyear Mechanical Rubber Goods are specified to the conditions of your work by the G.T.M.—Goodyear Technical Man. He will help lower costs and speed operation in your plant. To see him, just write to Goodyear, Akron, Ohio, or Los Angeles, Cal., and ask the G.T.M. to call.

THE GREATEST NAME IN RUBBER

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INDUSTRY HELPS SCHOOL TO TURN OUT PRACTICAL MINING MEN

STUDENTS of the Montana School of Mines, at Butte, have an unusual opportunity to supplement theory with practice, as they are privileged to put in two shifts a week in the mines of the operating companies on Anaconda Hill. They are thus able not only to obtain invaluable experience but also to earn their way through college, if necessary.

When the cages in the Butte shafts drop from the surface on Friday and Saturday evenings, they carry down with the thousands of night-shift miners a small group of young men—raw material from the Montana School of Mines. The hardy miners are very tolerant towards these aspirant engineers who, so the shift bosses say, fit in well and go at the work assigned them with a will.

When a student, who has had no experience underground, reports for his first two nights, the shift boss will probably give him a job cleaning track or trucking timber. Before long he will be able to "pull the chutes", to run a car, and to operate machinery of one kind or another. Then he may be called upon to help regular miners timber, to take a hand in mucking, to judge ground, and to break rock—thus eventually becoming a miner in his own right. He will learn to take care of his carbide lamp, to notch his fuses when "spitting", and to get first-hand information about sprags, stulls, girts, rills, caps, sills, buzzies, drifters, and the hundred-and-one things that are much harder to grasp by the use of text-books only. As a result of this training, some of the present upper classmen of the school have become such proficient miners that they are permitted to serve as shift bosses during summer vacations.

ZINC FROM SLAG BY NEW PROCESS

BUILT at a cost of $2,000,000, and operating at a higher capacity than that for which it was designed, the new slag-fuming plant of the Consolidated Mining & Smelting Company at Trail, B. C., represents the culmination of years of experimenting by that company to effect a chemical separation of zinc and lead oxide from silica, iron, and lime in lead blast furnace slags. The process developed and put in use marks, so it is said, the greatest achievement in zinc metallurgy in the last decade.

Mr. G. E. Murray, assistant smelter superintendent, has given the following description of the manner in which the values are recovered in the plant. Molten slag coming from the lead blast furnaces and carrying 18 to 20 per cent zinc in the form of oxide is poured into a water-cooled vessel and powdered coal is blown through the slag bath—an atmosphere being maintained that causes the oxide to be reduced to metallic zinc. The metallic zinc then vaporizes and burns to oxide. The gases are passed to one of two 1,750-hp. waste-heat boilers. They enter at 2,000° F. and leave at 600° F., and are further cooled to 200° F. in Greene economizer units. After that they are treated in a Draco automatic bag house—the resultant oxide going to the zinc plant for treatment. As much as 70 tons of zinc in fume has thus been produced daily.

A CONQUEROR OF SPACE, by Georgette Carneal. A book of 296 pages, published by Horace Liveright, New York City. Price. $3.00.

THIS timely volume is an authorized biography of Lee de Forest, to whom millions are now indebted for the daily enjoyment they get out of radio broadcasting. Had he not conceived the audion, the whole story of radio as we know it today might have been delayed indefinitely. With that as a start, Lee de Forest blazed the way not only for wonderful things of his devising but for astonishing adaptations of his audion wrought by others.

As the author tells us: "All his life long Lee de Forest has been wondering what made him an inventor instead of a minister, a teacher, or just a man holding down a job somewhere. But he can find no answer, no matter how far he searches in the streets and feelings of the past. Yet as far back as he can remember he has known, sometimes with a dreadful certainty, that this was his life's work, that he could no more change it or escape from it than he could change the color of his eyes."

This biography of Lee de Forest is extremely well written, and not only entertaining but an inspiration to all those others of an inventive turn of mind that have usually to face setbacks and even outspoken discouragement in plenty before the first faint glimmer of dawning recognition brightens the gloom. The spirit to fight for his conception is what really makes the inventor succeed, because in so many instances he must find ways to do what textbooks tell him positively cannot be done.

THE COMING OF INDUSTRY TO THE SOUTH. Edited by William J. Carson and published by the American Academy of Political and Social Science, Philadelphia, Pa. Price, $2.00.

TO be exact, this aggregation of articles dealing with various aspects of the industrial South constitutes the subject matter dealt with exclusively in the January, 1931, issue of *The Annals* of the American Academy of Political and Social Science. The different articles touch successively upon the industrial South of colonial days and the subsequent evolution of industry in that section of the country—bringing the story down to the present. Each topic has been competently handled by a recognized authority. The papers analyze many of the problems that have arisen as industries have grown and as communities in the southern states have changed from a predominantly agricultural to an agricultural and industrial society. We thus find that there are many adjustments underway and obstacles that limit progress; and steps are suggested that are believed necessary for the progressive adaptation of economic and social life to industrial changes in the future. An essential feature of this program is the restoring and preserving of agriculture while incidentally promoting the development of industry in bringing about "a balanced economy".

We believe this issue of *The Annals* will be welcomed by a very large circle of readers; and it is to be commended because of the scope of the topic matter dealt with.

DIGGING UP THE PAST, by C. Leonard Woolley. An illustrated work of 138 pages, published by Charles Scribner's Sons, New York City. Price, $2.00.

FOR the sake of those unfamiliar with the author, let it be said that he is the Director of the Joint Expedition of the British Museum and the Museum of the University of Pennsylvania to Mesopotamia.

This book might just as appropriately have been given the title, *Why the Archeologist?* Because, in the last analysis, it tells what these delvers into the past of mankind are bringing to light in the way of proof that we of the present are not so unlike the men and women who flourished in much pomp and lived under well-ordered conditions some thousands of years ago. The tomb of Tutankhamen, the Palace of Minos in Crete, and the royal burial places at Ur—remote as were their periods gaged by mere days, months, and years—are really little more than of yesterday compared with the geological periods of man's life upon this globe of ours. Even so, each "find" of this sort contributes convincing facts to the sociological background of the human race—proving true, time and again, what the vast majority of us believed to be little better than more or less generously colored fiction.

Astonishing and absorbing as are some of the things described in this little volume, nothing is more interesting than the way in which the trained eye of the archeologist sees on the seemingly unrevealing surface of the ground evidences of buried things that would pass unnoticed by the average person.

Contributions to Economic Geology, 1929, Geological Survey Bulletin 811, obtainable from the United States Government Printing Office. Price, $1. This bulletin deals with metals and nonmetals, except fuels, and contains papers on the New World mining district in Colorado; Indiana oölitic limestone; iron-ore deposits in Carbon County, Wyoming; and on building stones in the Salmon River Valley of Idaho. Apart from the industrial importance of these papers, they should be of much interest to persons seeking knowledge about the geological past of our continent.

THE PART PLAYED BY I-R CONDENSERS IN CENTRAL STATION PROGRESS

An Ingersoll-Rand condenser having 25,000 square feet of surface is installed under a 25,000-kw. turbo-generator in the Rio Grande Power Station of the El Paso Electric Company. This station is strategically situated on the Rio Grande River so as to obtain a maximum supply of condensing water in a country where water is at a premium.

A minimum requirement of both surface and circulating water is characteristic of the Ingersoll-Rand design. This particular installation, which has a two-pass water circuit, is operating under conditions that would ordinarily require almost twice as much surface and a three- or four-pass water circuit in a condenser of conventional design.

The condenser has a heart-shaped shell with graduated tube spacing, which allows free access for steam flow to all tube surface. A method for controlling the longitudinal distribution of steam, an exclusive Ingersoll-Rand patent, insures proper steam flow over the surface, particularly in the bottom of the tube bank.

External air coolers are also used, which thoroughly cool and devaporize the non-condensable vapors from the condenser.

The Rio Grande Power Station was designed and built by Stone & Webster Engineering Corporation. For a more detailed description, write for pamphlet No. 1853.

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